JUNE 13, 1960

American Machinist / Metalworking Manufacturing

A McGRAW-HILL Publication • Seventy-Five Cents

Quick-change tooling gives transfer line short-run efficiency—see page 109

Fundamentals of Interferometry

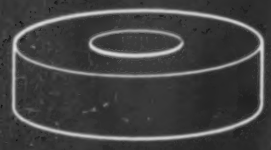
24-page Special Report, page 123

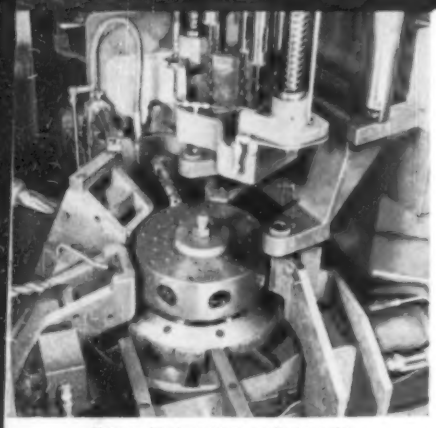
170 OPERATIONS

73 HOLES

starting from solid

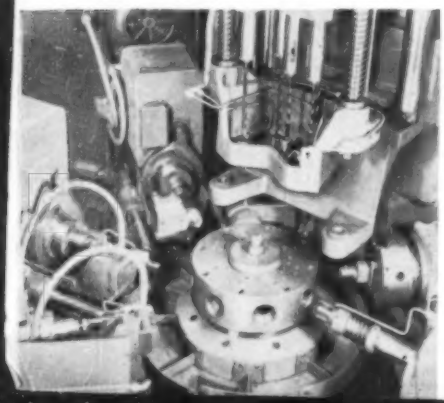
- DRILL
- REAM
- BORE
- COUNTER-BORE
- GROOVE
- TAP





Above — Work stations on first machine (shown in large photo)

Below — Work stations on second machine



Two 6-station Model S Bore-Matics

UP PRODUCTION 519%

This cast-iron hydraulic motor body used to be produced on three different machines, with a total production time of 286 minutes per part. Now it is done on two 6-station Model S Bore-Matics in *46 minutes!*

Each machine is equipped with Heald Red Head Borizers to rotate and feed the tooling, and a rotary indexing workholding fixture. Once the part is loaded, all operations are performed in sequence in a fully automatic cycle. After operations on the first machine are completed, the work is turned over and put on the second machine where the remaining operations are finished from the opposite face.

This job demonstrates the unusual versatility of Heald Borizer units—and their ability to handle heavy stock removal while maintaining required accuracy for each of numerous sequential operations. For complete details on this particular application, send for a copy of the April 1960 issue of the "Heald Herald."

MMT-PE

It PAYS to come to Heald

HEALD

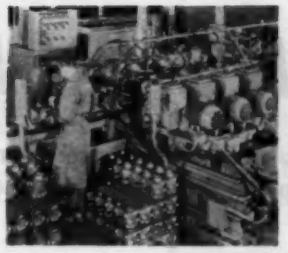
THE HEALD MACHINE COMPANY

Subsidiary of The Cincinnati Milling Machine Co.

Worcester 6, Massachusetts

Chicago • Cleveland • Dayton • Detroit • Indianapolis • Lansing • Milwaukee • New York • Philadelphia • Syracuse

COVER:
Transfer machine for "short-run" jobs built by Sundstrand. For details see page 109



American Machinist / *Metalworking Manufacturing*

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METALWORKING REPORT

Significant current developments in tooling and production processes

CUTTING

Turret Lathe Controls

Control systems for turret lathes, and special lathes to handle such systems, will be much in evidence when the new models come out this summer. Warner & Swasey (see page 122) has just announced a lathe with a built-in memory system that can handle 96 consecutive commands. Any single command can be adjusted or changed without affecting the setting of the others.

At least two other control systems on new turret lathes will be shown in Chicago. One is a new analog control. The machine on which it will be installed is believed to be able to hold tolerances of 0.0005 in. on the part being machined. The third is a complete redesign of a revolutionary numerically controlled turret lathe introduced at the 1955 Show.

One factor in this development may be the growing popularity of hydraulic drives for turret lathes. Recently, a turret lathe that was specifically designed to use the Lynn hydraulic drive (in fact, has the drive built into the lathe) was shown by Lincoln Industries at the ASTME show. Such drives have become very popular, with several hundred sold in recent years.

FORMING

Forging at 4500 F

Molybdenum ingots can now be forged into billets at temperatures up to 4500 F in the InFab facility of Universal-Cyclops. An Impactor (the Chambersburg automatic forging hammer with horizontally opposed hammers) operates in an argon atmosphere to forge ingots that have been heated in an induction furnace located just below the forging zone.

Control is from console located outside welded-steel enclosure, 42 x 97 x 23 ft. Argon gas filling enclosure is kept at 99.995% purity.

The Infab facility includes a small rolling mill, other furnaces, alligator shear, bar turner, pinch rolls, and a 10-ton crane. There is space to install machine tools for hot machining tests.

Other refractory metals, such as columbium, tantalum, tungsten, and their alloys will be processed in the InFab facility, built by the Refractomet Div of Universal-Cyclops with the cooperation of the Navy. Further details on page 120.

Blowing Giant Plastic Bubbles

Helicopter canopy bubbles are produced at the rate of 100 a month by Bell Helicopter, Globe, Texas, from 3/16-in.-thick Plexiglas on a fiberglass tool fixture designed and built by Bell. Bubble-blowing time has been reduced from seven hours to just 50 minutes in the last five years.

Inspected Plexiglas sheet is preheated to 325 F to make it flexible enough to install a blowing collar and clamping ring. Then the sheet is sealed to a rubber surface so that it will hold compressed air. It is now returned to the oven, brought back up to 325 F and held there for seven minutes.

At this time the bubble is partially sealed. It is then removed from the oven and blown to full size. Cooling takes 25 minutes.

INSPECTION

Mechanical Finger Nail

Your finger nail will indicate surface roughness within 20 to 30% accuracy; precision surface measuring machines within 5%. The finger nail test costs nothing, but you have to lay out maybe $1000 for the instrument.

The shop needs something between those two testing means in respect to both accuracy and cost. Rubert & Co Ltd, Cheadle, Cheshire, England, believes it has the answer in an inexpensive instrument based on measurement of the friction coefficient of machined surfaces. Accuracy is said to be between 10 and 20%.

Coefficients of friction are established by rubbing materials that have a surface roughness of less than 2 microns, because friction is then independent of the surface condition. Above this roughness level, the coefficient of friction is not linear, but the curve can be calibrated into the instrument.

The measuring unit consists of a sensing head in the form of a pivoted wheel. By moving the wheel back and forth on the surface to be tested, a scale pointer is caused to rotate against spring tension. By tensioning the spring until it balances the frictional drag, the wheel rotation is stopped. The indicator reading is retained by a ratchet and pawl.

Unlike stylus instruments, it is possible to explore the surface roughness of an extensive area in a short time with this instrument.

Before checking surface roughness, the scale is set by testing on a surface-roughness scale or block of the desired roughness value.

Interferometers in the Shop

Not all interferometers need be confined to master gage rooms and metrology laboratories. Many of them can be built and used in the shop—possibly in your shop.

You can use them to check length, parallelism, angles, surface condition, leadscrew pitch, and for many other inspection operations. For details on the history, construction, and application of interferometers, see the Special Report beginning on page 123.

HEAT TREATING

85-ft-High Furnaces

Seven new vertical furnaces for heat treating electric generator rotors have just been completed at U S Steel's Homestead Works. The new facilities, consisting of a quench

tower and an upending cradle in addition to the furnaces, were built primarily to meet the demand for rotors treated in an upright position after they have been forged and machined. This eliminates stresses which might develop if the rotor were treated in horizontal furnaces.

Housed in a new 100-ft-high building, the furnaces are set 35 feet below the floor, rise 50 feet above it, and can handle rotors 40 feet long and 60 in. in diameter.

The upending cradle is similar to those used in raising missiles into position. The quenching tower, 75 feet high, resembles a missile-launching superstructure. It has double doors, automatically operated and opening along the entire height of the tower, to admit the forging. Inside, the forging fits onto a rotating table which spins it in air or water jets until it is cooled to the desired temperature.

WELDING

Clean CO_2 Welding

The CO_2-shielded process can now make spatter-free welds in steel, according to Air Reduction Co, Inc. The company has introduced a new electrode wire with a very light coating that controls the current emission to produce a narrow, spray-type transfer of weld metal.

Unlike many of the recent new developments in welding, this one does not require any new equipment; the change is all in the electrode wire. However, in spite of the light coating, Airco says the wire can be considered bare, for all practical purposes. No special techniques are required, either, and, as the arc length is not critical, the process is suitable for manual, semi-automatic welding as well as automatic machine welding.

ASSEMBLY

Building-Block Assembly

Modular, interchangeable units for assembly lines were urged for industry by A Arnold Lawson, consulting project engineer, Mel-Par, Inc at the Design Engineering show in New York. Assembly units can be produced in large quantities, on their own assembly lines, to reduce costs. Each unit would perform a single function, with any assembly line made up of selected units to add up to a full production line.

Added advantage, according to Mr Lawson, is that modular units could be shifted around a plant to allow varied production and assembly on different products.

THE OUTLOOK:

Metalworking is looking forward to increased business in the third and fourth quarters of 1960. Machinery builders foresee these months as the best of the year, and most segments of the metalworking industry go along with this outlook. Steel production should begin to rise in July and build steadily. For details see pages 103 and 113.

FINISHING

Aluminum Plated on Copper

A method of plating aluminum on copper has been developed by Commonwealth Engineering Co, Ohio, for Wright Air Development Center. Copper panels were deoxidized by induction heating to 800 F in a hydrogen atmosphere. The chamber was then purged with argon as the work cooled to 500 F, and a mixture of gases containing tri-isobutyl aluminum vapor was admitted. The plate produced was virtually pure aluminum, lustrous and ductile, showed excellent conductivity, and was 4.7 mils thick. Adhesion varied from poor to excellent. A 64-page report on the process is available at $1.75 from OTS, US Dep't of Commerce, Washington 25, DC, as report PB 151023.

New Dip Improves Plating

For preparing copper for electroplating, a new process developed by Becco Chemical Div, Buffalo, NY, substantially reduces the porosity of thin deposits. In place of the usual acid pickle, the work is dipped in a 25% ammonium persulfate solution and rinsed in warm water. This produces an unusually clean surface, free of oxides, that will not reoxidize quickly.

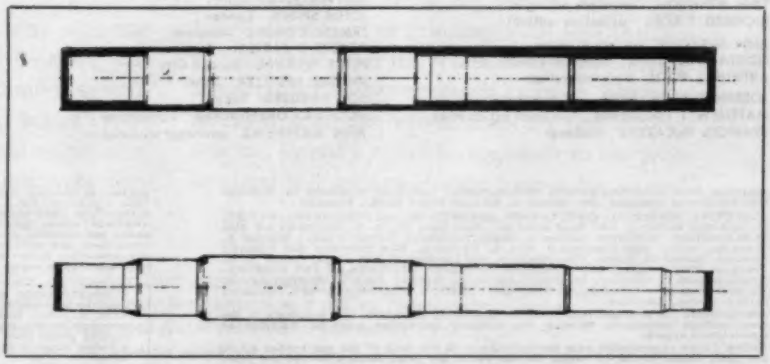
A hard nickel plate, 0.0003 in. thick, deposited on copper cleaned by this process showed a 73% reduction in the number of pinholes, compared with the same plate deposited from the same bath on acid-pickled copper. And a 0.0002-in. thick bright cyanide gold plate showed 85% reduction in pinholes against the same plate from the same bath on acid-pickled copper.

Conventional plating-room equipment may be used, including wooden, stainless, stoneware, or plastic tanks. The process is inexpensive, as 1 gal of solution will treat 100 sq ft of metal at a cost of only a few tenths of a cent per sq ft.

MATERIALS & COMPONENTS

Die-Formed Shafts

Centerless-ground bars have been replaced by die-formed Type 410 stainless-steel shapes (see sketch below) to virtually eliminate machining on propeller shafts for Evinrude boat engines. Depending on the engine model, four or five different diameters are required in each shaft. Previously, solid bars of stainless steel were lathe-turned to approximate these diameters. Now the shafts are die-formed by cold extrusion to the required step shape by Republic



Cold extrusion of propeller shaft minimizes waste material. Compare waste (dark areas) when shaft is machined from bar (top) and when cold extruded (bottom)

Steel Corp, Cleveland, and delivered to Evinrude ready for finish grinding. The operation is completed in one pass by a step-dressed grinding wheel.

Five hours have been cut from the time previously required to produce each 100 propeller shafts. In addition, there is a saving in metal, shipping weight, and handling. Outer diameter of the one-foot-long dieformed blank comes from Republic extruded to a tolerance of 0.020 in. At Evinrude, gear teeth are rolled in, then the blank is hardened and ground to finish form.

Plastic Resists 1800 F

Discovery of a new field of polymer chemistry showing "equal possibilities to the introduction of silicones" is claimed by Artrite Resins Ltd, Camberley, Surrey, England. New polymers stable to 1100 F and new resin products withstanding 1800 F have been developed. In addition to high thermal strength and thermal shock resistance, the new polymers have the molding characteristics of phenolic resins. A typical compound showed 23,500-psi shear strength at 1300 F on a punch test. More like ceramics than plastics, the compounds use the same preparative processes as conventional plastics and they are much tougher than ceramics.

Applications for these compounds are expected to include missiles, high-speed aircraft, household appliances and even domestic cooking utensils. The materials are being developed under defense contracts and no details have been released. However, the polymers are believed to contain both phosphorus and boron, which might place them in the new and exciting field of organometallics (*AM/MM*—Feb 22 '60, p89).

Ceramic Circuits

High-alumina ceramic boards with moly-manganese circuits screened onto them will replace more conventional printed circuits for high-temperature applications in five years, according to Harvey Pensack, president of Mitronics, Inc, Hillside, N J. Temperature tolerance is as high as 1800 F, and the materials will withstand exacting humidity and corrosive conditions.

One other advantage over present-day boards is that components may be hermetically sealed to one or both faces.

Moly-magnesium circuits are coated with electroplated nickel or copper as a base for solder. Through-plated holes are practical, and patterns can be located within 0.005 in.; holes within 0.001 in.

MANUFACTURING CONTROL

Dermatitis Prevention

Working on the theory that 80% of all industrial dermatitis cases are caused by failure of workers to wash properly after contact with caustic resins, cutting and lubricating oils, Liberty Mutual Insurance Co hygiene experts have come up with a simple inspection unit that costs just about $15. Liberty's idea: add a small amount of fluorescing material to oils and plastics. Then, after the worker washes his hands he puts them through an opening in a wedge-shaped box containing a "black light." Contaminated areas missed in washing show up clearly.

Electronic Truck Tester

Road-test a truck before it is even built? That's exactly what happened recently at the GMC Truck and Coach Div of General Motors Corp.

With a medium-size digital computer, engineers charted the progress of a new truck over a prescribed route, calculating such factors as trip time, average speed, and fuel consumption. Later they checked the computer's findings against performance of the actual truck. The results varied only 1%. Thus within a matter of minutes, and without actually building the truck, the plant gathered performance facts that would have taken months of field work to compile.

In operation, the computer accepts cards on which are recorded basic truck features, plus road conditions over a given route. It digests the information, then punches out the truck's performance characteristics on other cards. After engineers analyze these cards, they can chart the vehicle's progress every mile per hour for the length of the prescribed route.

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American Machinist/Metalworking Manufacturing, published bi-weekly by McGraw-Hill Publishing Company, Inc. James H. McGraw (1860-1948), Founder.

EXECUTIVE, EDITORIAL, CIRCULATION, ADVERTISING and PUBLISHING OFFICES: McGraw-Hill Building, 330 West 42nd St., New York 36, N. Y. OFFICERS OF THE PUBLICATIONS DIVISION: Nelson L. Bond, President; Shelton Fisher, Wallace F. Traendly, Senior V'ce Presidents; John R. Callaham, Vice President and Editorial Director; Joseph H. Allen, Vice President and Director of Advertising Sales; A. R. Venezian, Vice President and Circulation Coordinator. OFFICERS OF THE CORPORATION: Donald C. McGraw, President; Joseph A. Gerardi, Hugh J. Kelly, Harry L. Waddell, Executive Vice Presidents; L. Keith Goodrich, Vice President and Treasurer; John J. Cooke, Secretary.

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United States subscription rate for individuals in the field of the publication $3.00 per year, single copies 75 cents, Canada $4.00 per year, foreign $25.00 per year, payable in advance. Second-class postage paid at New York, N. Y. Printed in U. S. A.

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Mr. Hayward A. Gay, Vice President and Manager of Machine Tool Division, The Cincinnati Milling Machine Co., made the following remarks during his talk before The American Society for Abrasives.

Recent Past Foretells Greater Progress in Precision Grinding

"The recent advent of new precision measuring devices, which simply and accurately measure the size and roundness or flatness of a surface within millionths of an inch, has changed the entire concept of precision grinding as we knew it 15 years ago. Now that millionths of an inch can be detected in the shop, design engineers are hastening to specify near-zero tolerances. And the machine tool builder must provide machines which will produce them.

"Changing dimensional tolerances from ten thousandths of an inch, which was considered very close 15 years ago, to millionths of an inch requires many changes in machine structure, controls, abrasives and cutting fluid. An art has changed to a science. The skilled operator who was classed as an artisan can accomplish tolerances of ten-thousandths by feel of the job, but millionths are beyond the capacity of the artisan's feel.

"Fifteen years ago, micrometers were adequate for size adjustments on most jobs. Grinding machines were simple mechanical structures with variable traverse rates to the table and infeed cycles against a positive stop. Wheels were variable in structure and hardness. Cutting fluids were considered necessary only to cool the work and prevent rust.

"Today, the requirements are much different. Conditions demanding the change may be partially listed as follows:

- Increased application of precision grinding
- Size and finish tolerances much more exacting
- More exotic materials and alloys to grind
- Fewer skilled operators available
- Human error must be removed
- Complete automation desired on mass production jobs

"Satisfying these new grinding requirements can be accomplished only through extensive scientific development of the machine, the wheels and the cutting fluid. Much remains to be done and will be done in these areas of precision grinding, or perhaps we should say, *super*-precision grinding.

"You have asked for my candid view of the future for the art of grinding. I am sure that you will conclude from the points mentioned here that this art is becoming very much a science. The trend to closer precision, exotic materials and automation has forced a scientific approach to the problem, and will continue for the foreseeable future."

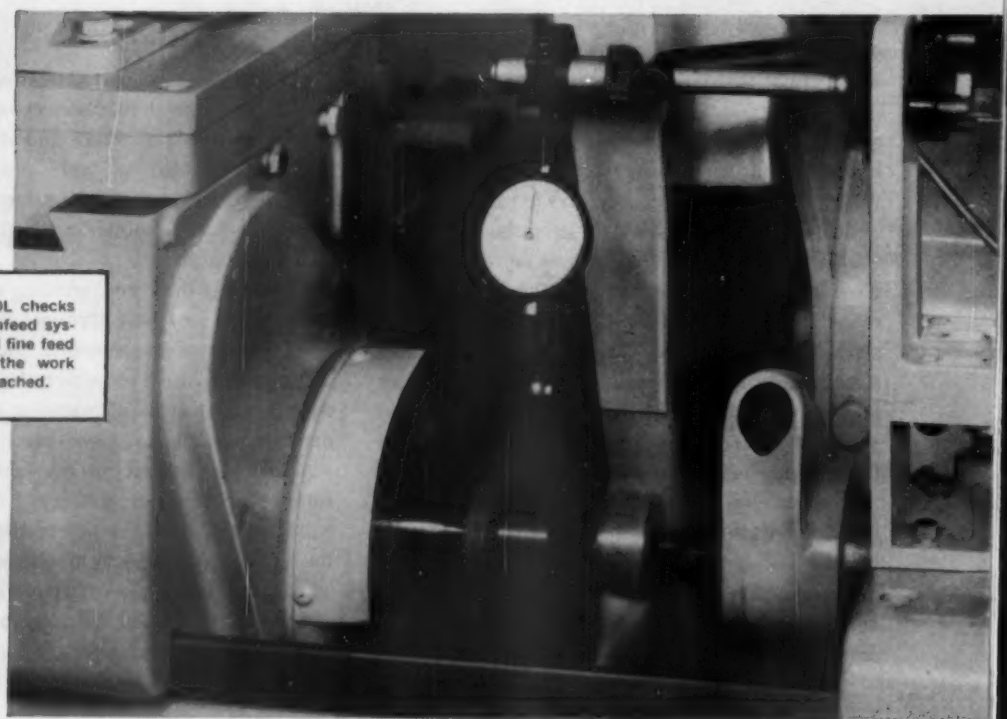
•*The following two pages illustrate how Cincinnati reduces costs by meeting three precision grinding requirements: more exacting size and finish tolerances, automatic cycling, and the removal of human error.*

The Cincinnati Milling Machine Co., Cincinnati 9, Ohio.

CINCINNATI

Compare automatic infeed systems...see why

ACRASIZE CONTROL is the best



ACRASIZE GAGE CONTROL checks in the entire automatic infeed system, including coarse and fine feed rates; and checks out the work when accurate size is reached.

MMT-PE
MODERN MACHINE TOOLS
PRODUCTION EFFICIENCY

Booth No. 1034

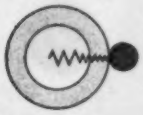
BUILDERS OF PRECISION GRINDING MACHINES: CENTERTYPE • CENTERLESS • MICRO-CENTR

THE CINCINNATI MILLING MACHINE CO., CINCINNATI 9, OHIO

CIRCLE 155 READER SERVICE CARD

There's a new look in precision grinding operations. Today's microscopic tolerances are transforming an art into a science. And in the new technology, Cincinnati continues to lead the industry with developments such as ACRASIZE—the exclusive gage control system which calls the signals for the entire automatic infeed cycle. Maximum timesaving and extra high quality are attained by combining the following:

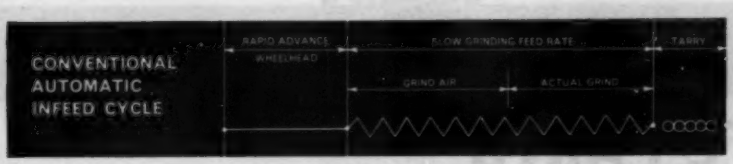
Automatic Dual Rate Infeed (lever or push-button operated) gives you fast, accurate grinding cycles with dual feed rates . . . coarse feed for rapid stock removal, followed by an extremely *smooth and continuous* fine feed to exact size. No gage required.

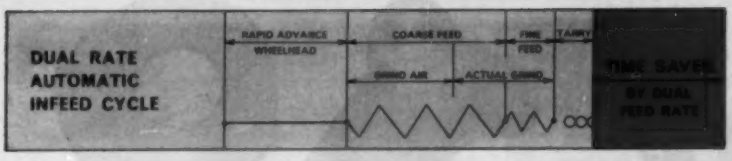


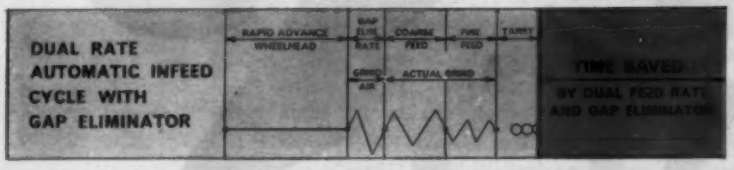
Automatic Gap Eliminator reduces infeed cycle time. This Cincinnati development saves as much as 75% of the time normally wasted in grinding air.

ACRASIZE Gaging with Cycle Time Stabilizer provides complete control of the grinding cycle. Effects of machine thermal changes, wheel wear and work variations are eliminated as the ACRASIZE gaging head continuously measures diameter of part being ground . . . and wheelhead retracts at exact instant desired size is obtained. Cycle time always remains constant because ACRASIZE incorporates the built-in Cycle Time Stabilizer, automatically compensating for wheel wear and truing.

These three Cincinnati feature-advantages give you a basis for comparison of automatic infeed systems. Check them all and you'll see why Cincinnati produces the highest quality work at rock-bottom cost. May we hear from you? Our Grinding Machine Division specialists will be glad to discuss these and other Cincinnati developments with you.







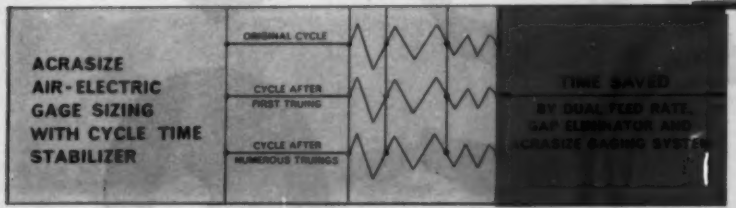

ACRASIZE AIR-ELECTRIC GAGE SIZING WITH CYCLE TIME STABILIZER
ORIGINAL CYCLE
CYCLE AFTER FIRST TRUING
CYCLE AFTER NUMEROUS TRUINGS
TIME SAVED BY DUAL FEED RATE, GAP ELIMINATOR AND ACRASIZE GAGING SYSTEM

Chart at left shows time saved by ACRASIZE compared with conventional automatic infeed grinding cycles. Details in Catalog G-688.

FILMATIC

Below: CINCINNATI FILMATIC 10"R x 18" Plain Grinding Machine equipped with the timesaving feature-advantages diagramed at the left. Catalog G-661-2.

ROLL • CHUCKING • CENTERLESS LAPPING

CINCINNATI®
GRINDING MACHINE DIVISION

CIRCLE 156 READER SERVICE CARD

INVOLUTE GEARS

FELLOWS

NON-INVOLUTE PARTS

Fellows
4GS Gear Shaper

GEAR SHAPERS DO DOUBLE DUTY

Fellows Gear Shapers are not limited to the production of gears alone. They are valuable production machines ideal for the manufacture of *many* types of parts, of both involute and non-involute form.

As gear shapers, they provide high production rates in the manufacture of internal and external spur and helical gears. As general purpose production machines, they also make possible the economical production of irregularly shaped parts . . . in many cases doing in one simple operation what would require several operations using conventional shop tools.

If you manufacture gears in your plant, chances are the Fellows Gear Shaper is already an important part of your production process. If you manufacture irregularly shaped parts, find out how the Fellows Gear Shaper can help you increase production and cut costs.

Your Fellows representative will be happy to give you further information on the complete line of Fellows production and inspection equipment. Ask him, or write direct.

THE FELLOWS GEAR SHAPER COMPANY
78 River Street, Springfield, Vermont, U.S.A.
Branch Offices:
1048 North Woodward Ave., Royal Oak, Mich.
150 West Pleasant Ave., Maywood, N.J.
5835 West North Avenue, Chicago 39
6214 West Manchester Ave., Los Angeles 45

THE PRECISION LINE

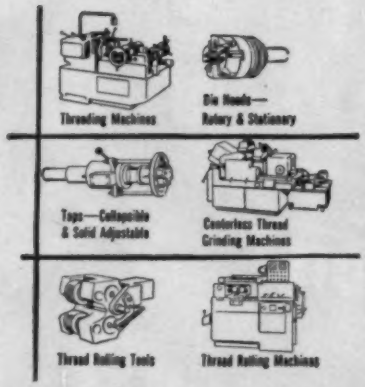
Fellows *Gear Production Equipment*

THREADING

Suburban Industries, Bensenville, Illinois, is achieving these results with a compactly-designed LANDMACO 5C Threading Machine equipped with a 5/8" VVV LANCO Hardened and Ground Die Head. Performance is not limited to one application—both steel studs and continuously-threaded bars are produced at 581 R.P.M. (76 surface feet per minute).

Chaser life is excellent. For example: 10,000 studs of B 1113 steel, having a 1/2" UN thread 3/4" in length, are produced between chaser grinds. Furthermore . . . in the continuously-threaded rod application, with 1/2" 13 pitch UN threads in 12-foot lengths, 150 bars of B 1113 steel (1800 linear feet of thread) are produced between chaser grinds. The long life between chaser grinds is the result of using a rugged LANCO die head equipped with LANDIS Tangential Chasers which can be reground for 80% of their original length.

The 5C LANDMACO Machine is manufactured in a single-spindle model for threading all diameters from 3/16" to 5/8" to Class 4 fit. The availability of lead screw feed, air-operated carriage return, air-operated carriage fronts, and special fronts for difficult-to-grip workpieces allow maximum production efficiency. Send us specifications of your workpiece and ask for Bulletin H-74 . . . let us show you how a LANDMACO Machine will handle your threading operation efficiently and economically.



LANDIS *Machine* COMPANY

WAYNESBORO • PENNSYLVANIA • U. S. A.

THE WORLD'S LARGEST MANUFACTURER OF THREADING EQUIPMENT

MMT-PE

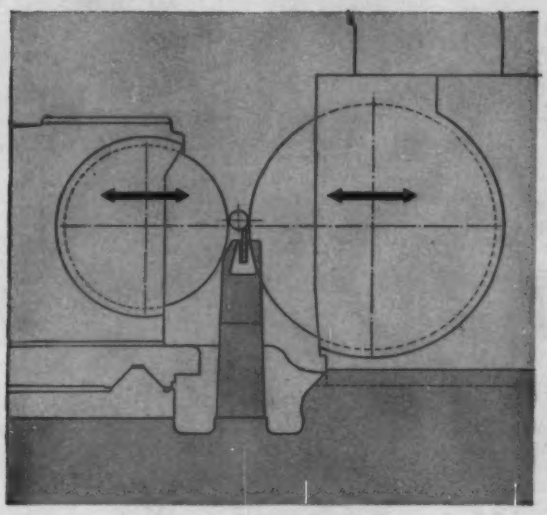
BOOTH NO. 432

517C

CIRCLE 160 READER SERVICE CARD

Exclusive Landis work rest design gives high

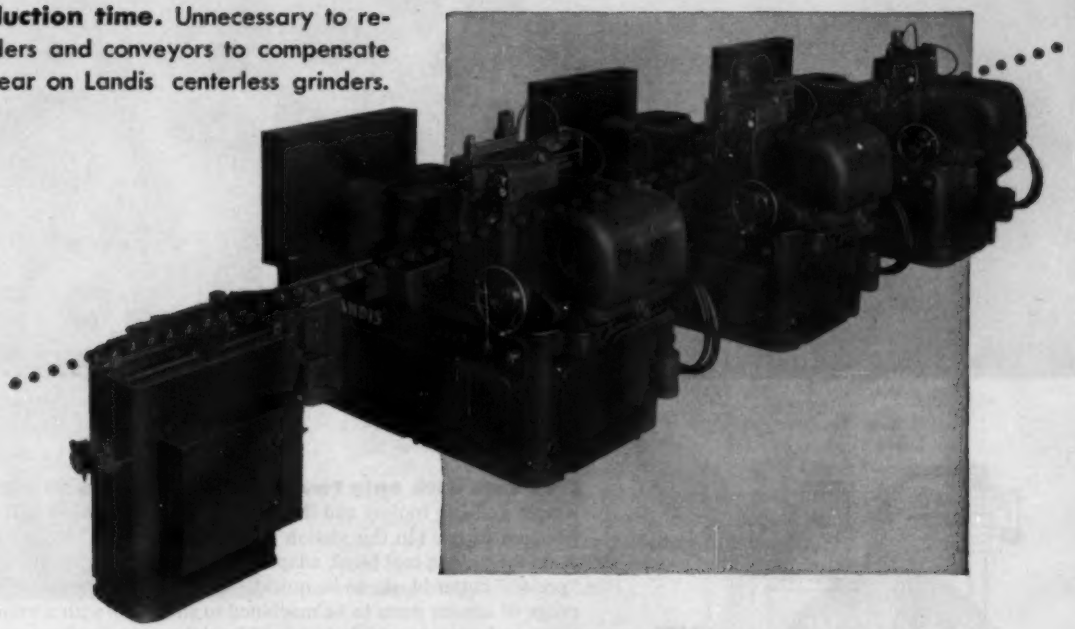
centerless output *plus* close tolerances



Landis method of centerless grinding. Extra heavy cuts can be taken with this rigid, bed mounted work rest.

Solid support for accuracy and finish. Close tolerances and fine finishes maintained at high production rates.

More production time. Unnecessary to reposition loaders and conveyors to compensate for wheel wear on Landis centerless grinders.



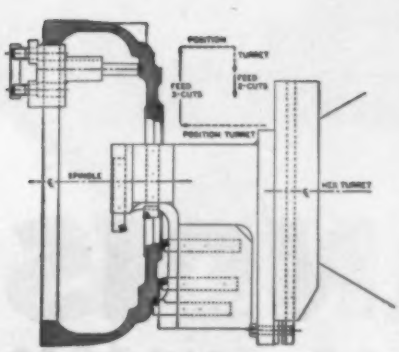
MMT PE

LANDIS TOOL COMPANY

WAYNESBORO, PENNSYLVANIA

LANDIS

precision grinders



Five cuts with only two machine settings are accomplished with simple multiple tooling and the four-way feeding motion of the cross sliding hexagon turret. (In this station only the "in-and-out" cross feeds are used.) Note the unique tool block adapters mounted on the hex turret. They permit "pre-set" cutter blocks to be quickly and accurately positioned—allow a wide range of similar parts to be machined in small lots with a minimum of setup time—and provide a high degree of interchangeability between setups on the same machine or from one machine to another. General use of "throw-away tips" keeps downtime for cutter replacement to a minimum.

At left: Schematic diagram of above operation shows multiple cutter block tool layout, turret positioning and feed direction, and holding method for the turbine housing.

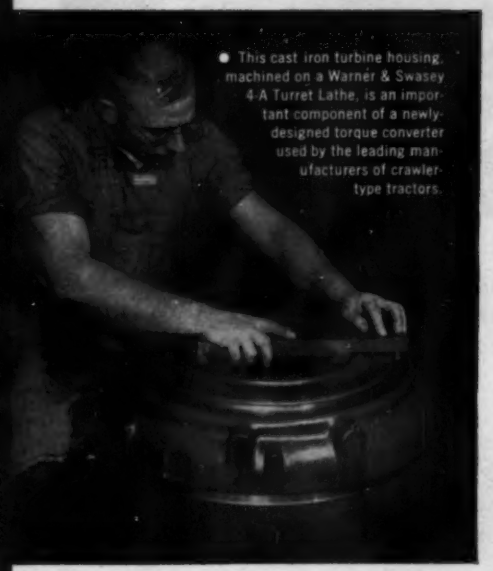
CIRCLE 163 READER SERVICE CARD

On this Warner & Swasey 4-A Turret Lathe...

FOUR-WAY FEEDING MOTION

of Cross Sliding Hexagon Turret

- **PERMITS SIMPLER MULTIPLE TOOLING—GREATER FLEXIBILITY**
- **REDUCES BOTH MACHINE HANDLING AND CUTTING TIME**



● This cast iron turbine housing, machined on a Warner & Swasey 4-A Turret Lathe, is an important component of a newly-designed torque converter used by the leading manufacturers of crawler-type tractors.

Machine handling operations were cut in half—from 14 to only 7—in the production of these complex 26½" diameter turbine housings. In addition, the efficient utilization of the simpler "multiple-cut" turret tooling by the versatile four-way feeding motion of the cross sliding hexagon turret made significant reductions in cutting time.

As a result, floor-to-floor time was reduced 28%—from 41.7 to 30.0 minutes. This work was formerly run on vertical and "fixed-center" turret lathes.

Handled in 100-piece lots on their two new Warner & Swasey 4-A Saddle Type Turret Lathes, bore tolerances of .002-inch total are easily held along with concentricities of .005-inch T.I.R.

Note these cost-cutting advantages of the cross sliding hexagon turret attachment:

1. *Simpler, less expensive tooling accomplishes special purpose tool results on complex parts.*
2. *Provides the reach necessary for turning, multiple facing and boring a full range of large diameters, including deep bores, back faces, recesses and tapers.*
3. *Lower setup time—hence small lots are practical.*
4. *Versatility—can be inexpensively tooled for either volume or small-lot production of large, complex parts. It's also readily adaptable as a fixed-center machine for handling routine turret lathe work.*

Your Warner & Swasey Field Engineer will gladly present the complete story of how versatile cross sliding hexagon turret equipped Saddle Type Turret Lathes can handle your more complex turning jobs—faster and more economically. Call him today.

WARNER & SWASEY
Cleveland
PRECISION MACHINERY SINCE 1880

YOU CAN PRODUCE IT BETTER, FASTER, FOR LESS...WITH A WARNER & SWASEY

JONES & LAMSON MACHINE TOOLS

the man who needs a new machine tool is already paying for it

Two-dimension tracing eliminates secondary operations and reduces costly "off" machine time

Two-dimension tracing, combined with conventional turret lathe tooling, provides an extremely versatile method for complete machining to tight specifications.

For instance, the end use of the connecting rod bolt (illustrated above) demands extremely fine finish to eliminate the starting of fatigue cracks. In addition, relief surfaces, O.D., head faces, and threaded end must all be square and concentric. Radii of fillets connecting the different diameters must be smooth and free from scratches. Two reliefs, each 6½" in length, must be held to + or — .002" and to 40-50 RMS to eliminate subsequent grinding operations. The finished parts are 19-3/4" long with different O.D.'s varying from 1-1/2" to 2-7/16". The material is tough: AISI 4140; Brinell 241.

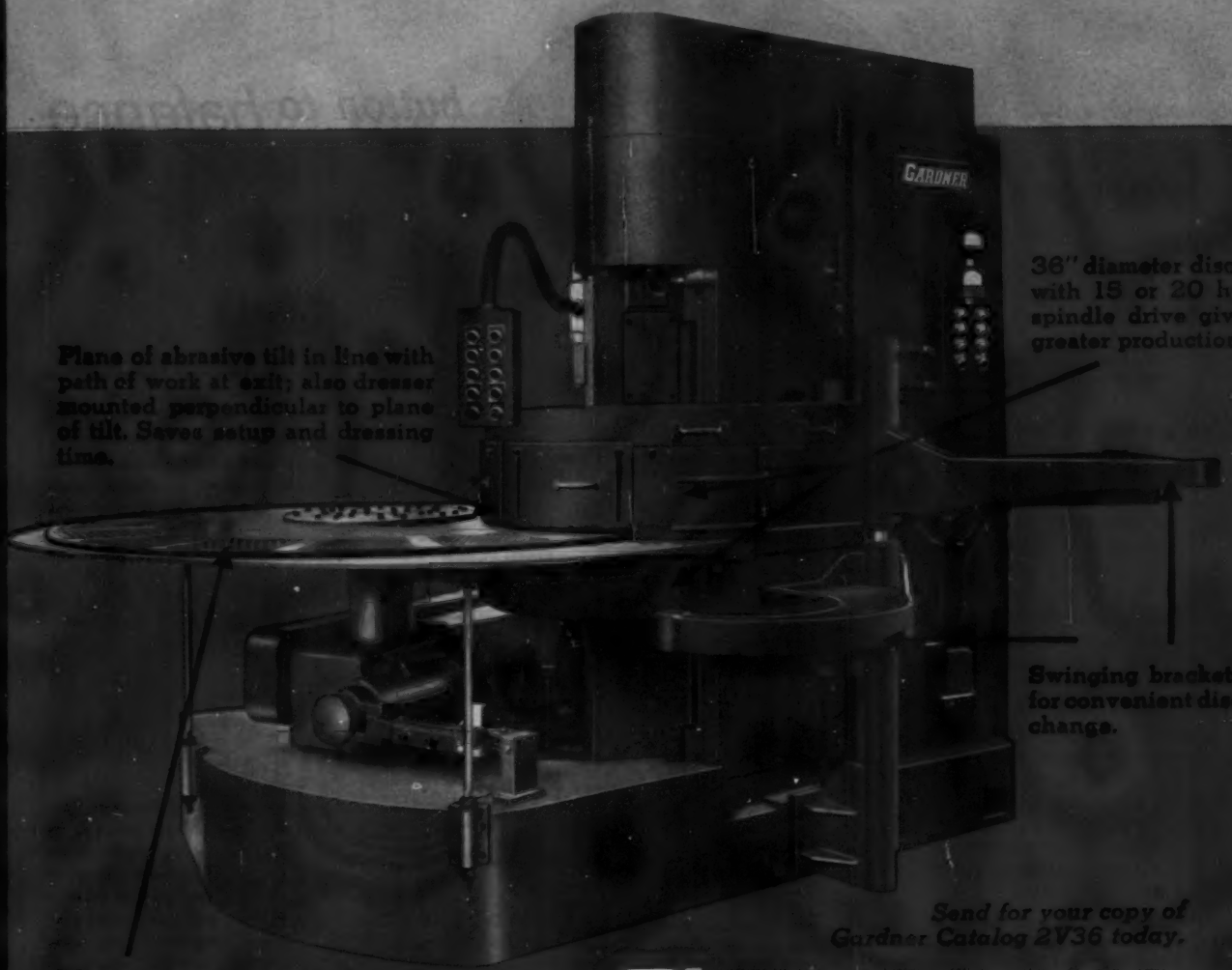
All this is accomplished in one tooling set-up on a J&L turret lathe with a two-dimensional tracer. Floor-to-floor time for finished parts is less than three minutes on the head end, and less than nine minutes on the shank end. Write for Folder #5903.

Jones & Lamson Machine Company, 502 Clinton Street, Springfield, Vermont.

Turret Lathes • Automatic Lathes • Tape Controlled Machines • Thread & Form Grinders • Optical Comparators • Thread Tools

new Gardner 2V36 double vertical spindle grinder

grind TWO parallel surfaces in ONE operation



Plane of abrasive tilt in line with path of work at exit; also dresser mounted perpendicular to plane of tilt. Saves setup and dressing time.

36" diameter discs with 15 or 20 hp spindle drive give greater production.

Swinging brackets for convenient disc change.

78" rotary work carrier has adjustable oscillation; discs stay flat longer and workpieces have greater accuracy. Also saves time when dressing because work carrier swings outward and need not be completely unloaded.

Send for your copy of Gardner Catalog 2V36 today.

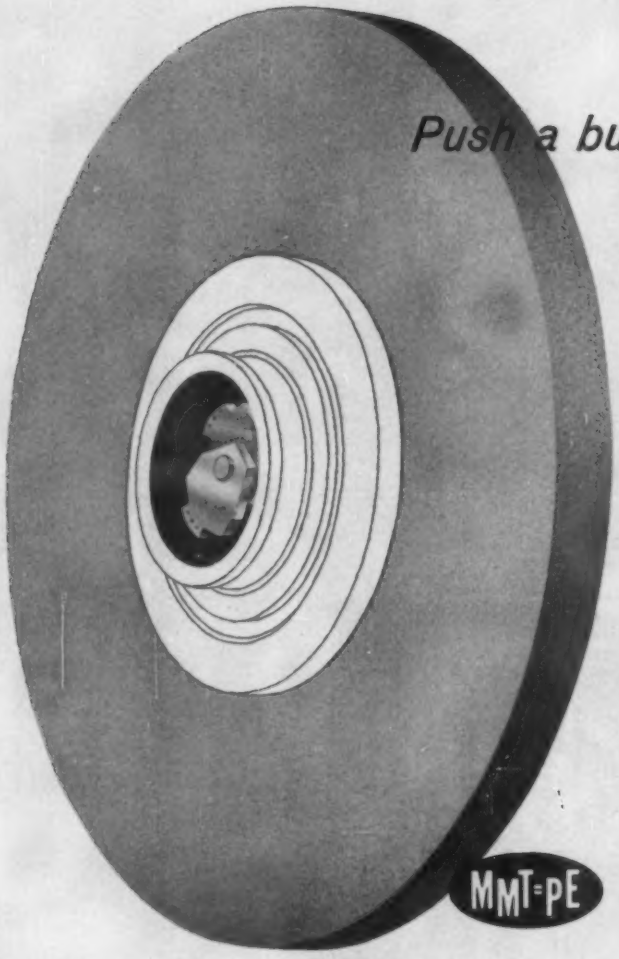
GARDNER

precision disc grinders

BELOIT, WISCONSIN

A. Unbalance. Badly out of balance wheel is shown in grinding position on the NORTON Balancer. Pendulum weights are locked in balance correcting position for wheel previously in use. Heavy spot, shown by yellow area, tends to displace center line of wheel spindle from normal center of rotation.

Push a button to balance

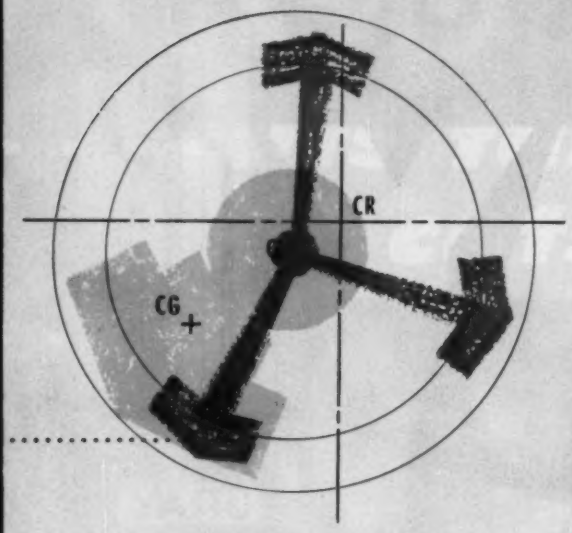


B. The Button Is Pushed. Wheel adapter assembly moves to soft spring suspension. Assembly tries to rotate about center of gravity. Centrifugal force acting outwards from center of rotation causes pendulum weights to move away from heavy spot, as shown.

C. Balanced in 5 Seconds. Pendulum weights have moved to the correct balancing position opposite the heavy spot. Center of gravity, center line and center of rotation are now common as shown. Weights lock and wheel adapter assembly returns to grinding position.

Unusual simplicity of the new NORTON Automatic Wheel Balancer introduces new advantages to unusual grinding operations. The wheel spindle and bearings are never released from carefully fitted housing. Balancing action is developed by slight release of *only* the wheel assembly from nose of spindle, permitting the assembly to be carried while balancing on a floating spring shaft. Three pendulum type balancing weights give maximum sensitivity to positioning forces. Wheel assembly and balancing weights are clamped and released automatically. Loosening a single spanner nut enables quick wheel changes. Safety interlock prevents operation of mechanism during grinding.

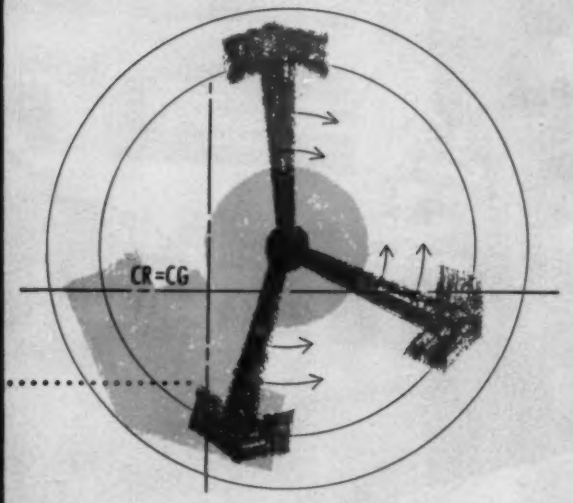
NORTON PRODUCTS: Abrasives • Grinding Wheels • Machine Tools • Refractories • Electro-Chemicals — **BEHR-MANNING DIVISION:** Coated Abrasives • Sharpening Stones • Pressure-Sensitive Tapes

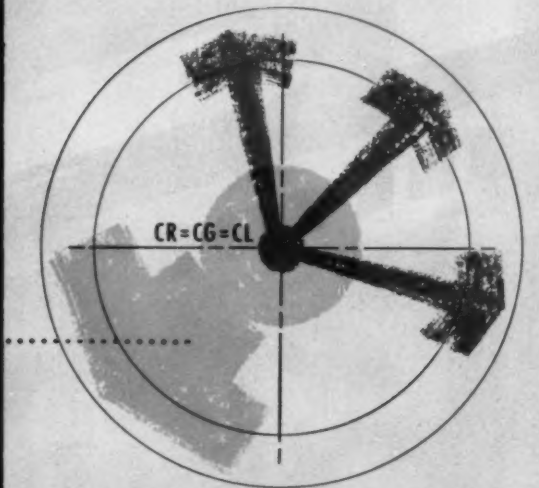


CG = Center of Gravity
CL = Center line of Wheel Spindle
CR = Normal center of Rotation

grinding wheels precisely . . .

automatically in 5 seconds





New and optional, the NORTON Automatic Wheel Balancer simplifies an extra operation for extreme precision grinding.

Engineered for ruggedness and high precision, NORTON cylindrical grinders have long been recognized for producing completely satisfactory results without wheel balancing — on or off the machine.

That holds good for all but a very small minority of grinding jobs calling for the absolute extreme in precision grinding. It is for such special requirements that the NORTON Automatic Wheel Balancer is designed.

That is why it is optional on most NORTON cylindrical grinders — and that is how it teams up to produce more positive precision than has ever been obtainable with previous wheel balancing methods.

Read the diagrammed descriptions shown here. See how simply, surely and swiftly the NORTON Automatic Wheel Balancer brings new advantages to wheel balancing for maximum precision grinding. For further details, see your Norton man, a Trained Grinding Engineer. Or write to NORTON COMPANY, Machine Tool Division, Worcester 6, Mass. *District Offices:* Worcester, Hartford, Cleveland, Chicago, Detroit. *In Canada:* J. H. Ryder Machinery Co., Ltd., Toronto 5.

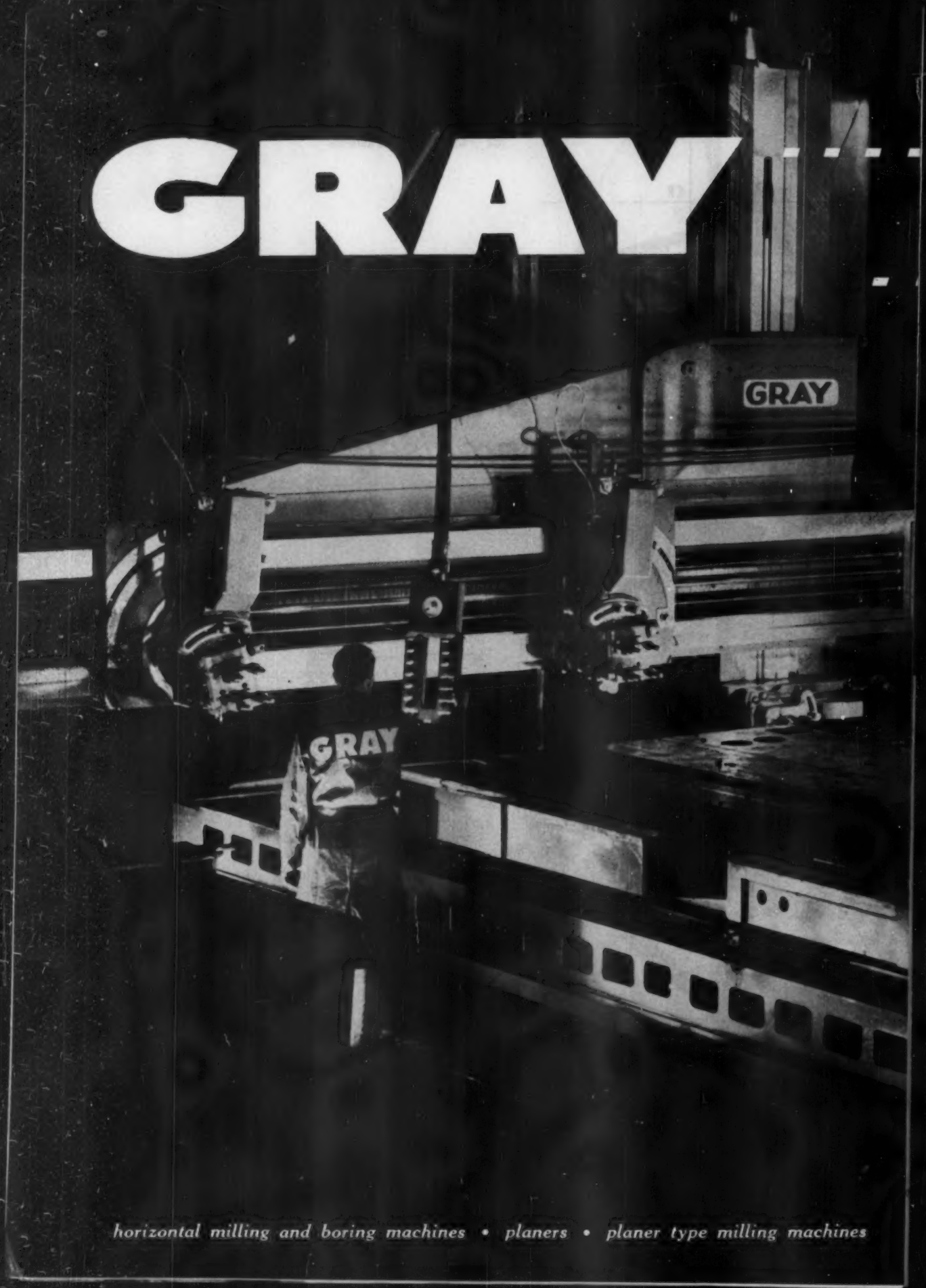
NORTON
MACHINE TOOLS

75 years of . . . Making better products . . .
to make your products better

MACHINE TOOL DIVISION: Grinding and Lapping Machines — B & E DIVISION: Shapers • Gear Cutting Machines • Gear Induction Hardeners

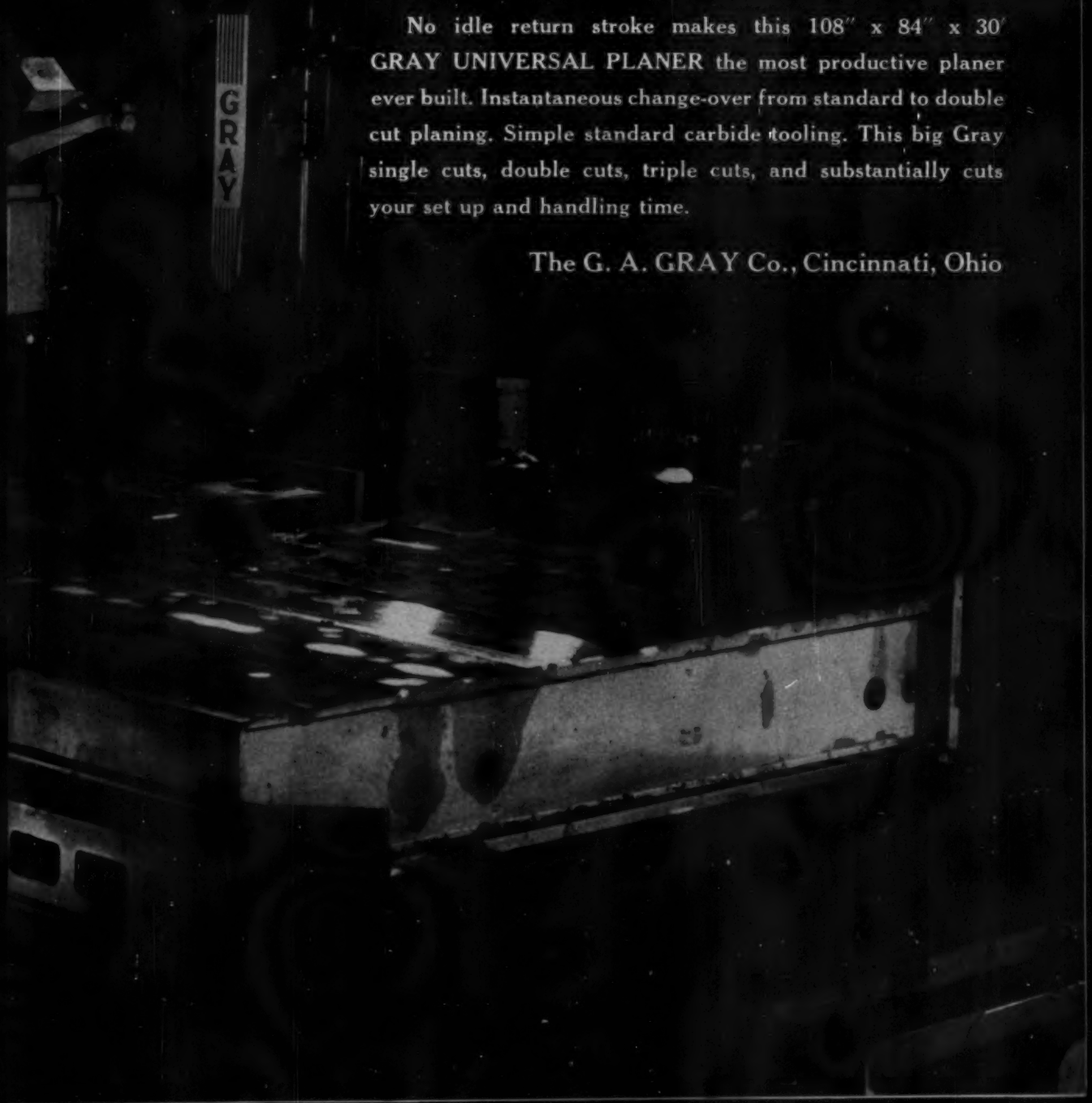
CIRCLE 168 READER SERVICE CARD

CIRCLE 169 READER SERVICE CARD ►



horizontal milling and boring machines • planers • planer type milling machines

. . cuts fast
. . . . . cuts both ways
. . . . . cuts costs



No idle return stroke makes this 108″ x 84″ x 30′ GRAY UNIVERSAL PLANER the most productive planer ever built. Instantaneous change-over from standard to double cut planing. Simple standard carbide tooling. This big Gray single cuts, double cuts, triple cuts, and substantially cuts your set up and handling time.

The G. A. GRAY Co., Cincinnati, Ohio

portrait of an emotional scar

How can you depict the shock, anger and disappointment that really takes place when it happens? How does *anybody* know how it feels to see a die crack during the last few minutes of heat treating? How can anybody know, except the man responsible for purchasing the original piece of steel?

What went wrong? Heat treating procedures checked out O.K. And it *should have* been a good piece of steel. It came from a reliable mill that uses all the standard methods of specialty steelmaking and applies all the normal quality controls. Furthermore, tool and die steel from the same mill had been satisfactory on other jobs.

Predictable performance . . . no predicaments. *Carpenter's revolutionary new* MEL-TROL® *process* is not a standard method for making specialty steels. It's exclusive. It utilizes a new patented mold which reduces segregation of harmful impurities during solidification of the ingot. This ingot is far more uniform. You get steel which is cleaner, sounder, tougher from surface to center . . . in every bar . . . in every lot. It takes the guesswork out of toolmaking, because you know *in advance* what results you will get.

Avoid emotional scars. Next time order Tool and Die Steels from your nearby *Carpenter* SERVICE-CENTER. You'll look better in the eyes of your Company.

tool and die steels
stainless steels
electronic, magnetic and electrical alloys
high temperature alloys
special-purpose steels
tubing and pipe
fine wire specialties

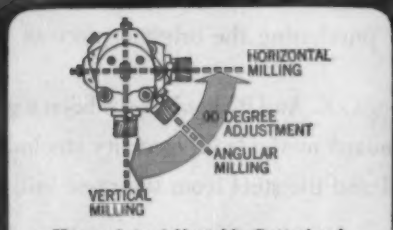
Carpenter **steel**

Steel

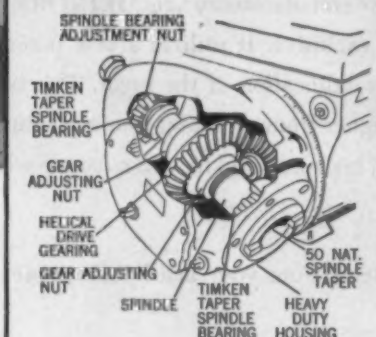
The Carpenter Steel Company, Main Office and Mills, Reading, Pa.
Alloy Tube Division, Union, N. J.
Webb Wire Division, New Brunswick, N. J.
Carpenter Steel of New England, Inc., Bridgeport, Conn.

CIRCLE 172 READER SERVICE CARD

All industry is talking about the new Van Norman



Heavy duty Adjustable Cutterhead, standard on Nos. 16M, 24LA, 24MA, 28A, 38MA and 38MEA Van Norman Milling Machines.



Cutaway view of Adjustable Cutterhead showing heavy duty construction. Spindle bearings are sealed and lubricated for life.

SYNTHANE CUTS

VN Milling Machine

Synthane Corporation, a leading manufacturer and fabricator of industrial plastics, wanted speed of production, versatility, and accuracy in a milling machine. They found them with Van Norman . . . as demonstrated when they ordered seven *additional* VN Milling Machines after they achieved such outstanding results with the first—production speeding results that paid off in cold cash for Synthane.

VAN NORMAN

SPRINGFIELD 7, MASSACHUSETTS

3379

THERMOSETTING PLASTIC MILLING TIME 25%

speeds output...holds tolerances...makes possible many production set-ups

Production Time Cut 25% to 30%—With the new VN Milling Machine, Synthane has been able to cut production time 25% to 30% . . . an enormous cost factor. Moreover, the VN Milling Machine gives more varied production . . . is easily adaptable for a wide range of jobs. And gives more accurate, unsupervised production, too. Once set, VN Milling Machines can be run indefinitely on a particular job without rechecking . . . and deliver the same precision and fine tolerance on the last piece milled as they did on the first.

And Van Norman Milling Machines can deliver the same fine cost-saving results for *you*.

Get Detailed Information—Your local VN Franchised Distributor will be happy to show you how VN Milling Machines can cut your production time . . . and costs. For his name write direct to VN, Springfield, Mass.

MACHINE COMPANY
A DIVISION OF VAN NORMAN INDUSTRIES, INCORPORATED

VN

ARMSTRONG
TOOL HOLDERS
A Correct Tool for Every Lathe Operation

You can save time (and money) by ensuring that your machine tools are equipped with *adequate numbers* of the correct ARMSTRONG Tool Holders. The ARMSTRONG System of Tool Holders includes correctly designed tools for *every* standard operation on lathes, shapers, and planers, and for many operations on turret lathes and screw machines. By utilizing the ARMSTRONG System of Tool Holders, you can reduce tooling costs, eliminate down time in tooling up, operate your machine tools at maximum feeds and speeds.

ARMSTRONG Tool Holders are long-lasting tools. They are strong beyond need, handy and efficient, profitable to use, and are readily available from your local ARMSTRONG Distributor.

Check over your ARMSTRONG Tool Holder needs.
Write for literature.

If you do not know the name of your local ARMSTRONG Distributor, inquire when asking for literature.

ARMSTRONG BROS. TOOL CO. 5215 W. ARMSTRONG AVE. CHICAGO 46, ILL.

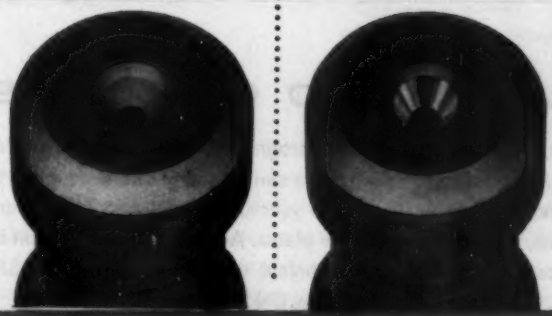
DO YOUR OPERATIONS DEMAND ACCURATE CENTERS?

Ex-Cell-O Center Lapping Machines Increase Accuracy, Reduce Scrap!

Precision Center Lapping Machines remove heat-treat scale, and eliminate roughness and distortion of centers to insure accuracy in subsequent operations.

Easy to use and modestly priced, Center Lapping Machines include as standard, inbuilt equipment Ex-Cell-O Precision Spindle and manual diamond dresser.

See your Ex-Cell-O Representative, or write for Bulletin 40271.

BEFORE LAPPING		AFTER LAPPING
• Out of line • Out of round • Incorrect angle • Rough or torn		• Perfect alignment • True roundness • Precise angle • Mirror-smooth

60-37

EX-CELL-O FOR PRECISION

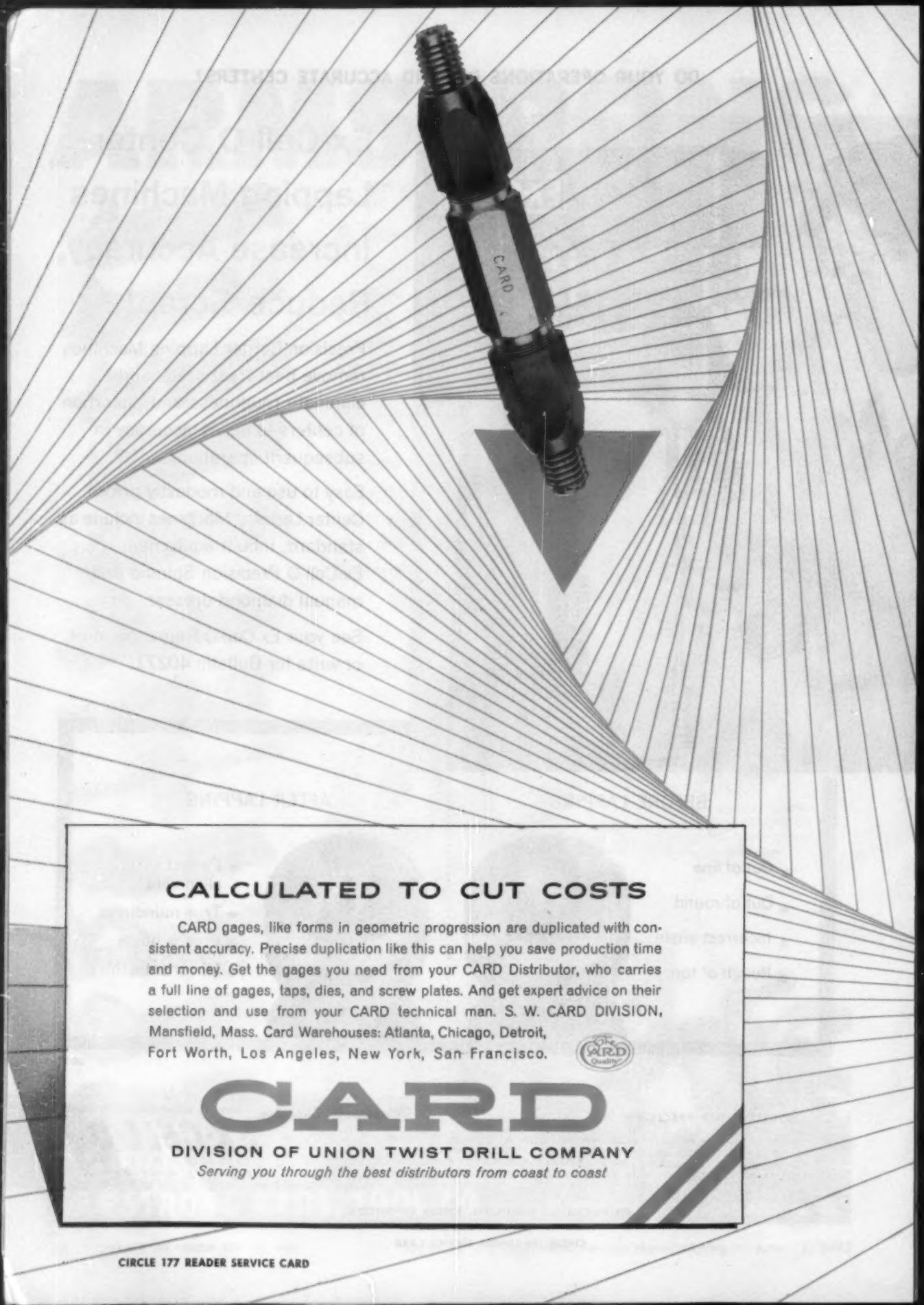
EX-CELL-O PRECISION PRODUCTS INCLUDE: MACHINE TOOLS • GRINDING AND BORING SPINDLES • CUTTING TOOLS • RAILROAD PINS AND BUSHINGS • DRILL JIG BUSHINGS • TORQUE ACTUATORS • GAGES AND GAGING EQUIPMENT • GRANITE SURFACE PLATES • ATOMIC ENERGY EQUIPMENT • AIRCRAFT AND MISCELLANEOUS PRODUCTION PARTS • DAIRY EQUIPMENT

Machinery Division

EX-CELL-O CORPORATION
DETROIT 32, MICHIGAN

SEE EX-CELL-O'S BOOTH 946, NMTBA EXPOSITION

CIRCLE 176 READER SERVICE CARD



CALCULATED TO CUT COSTS

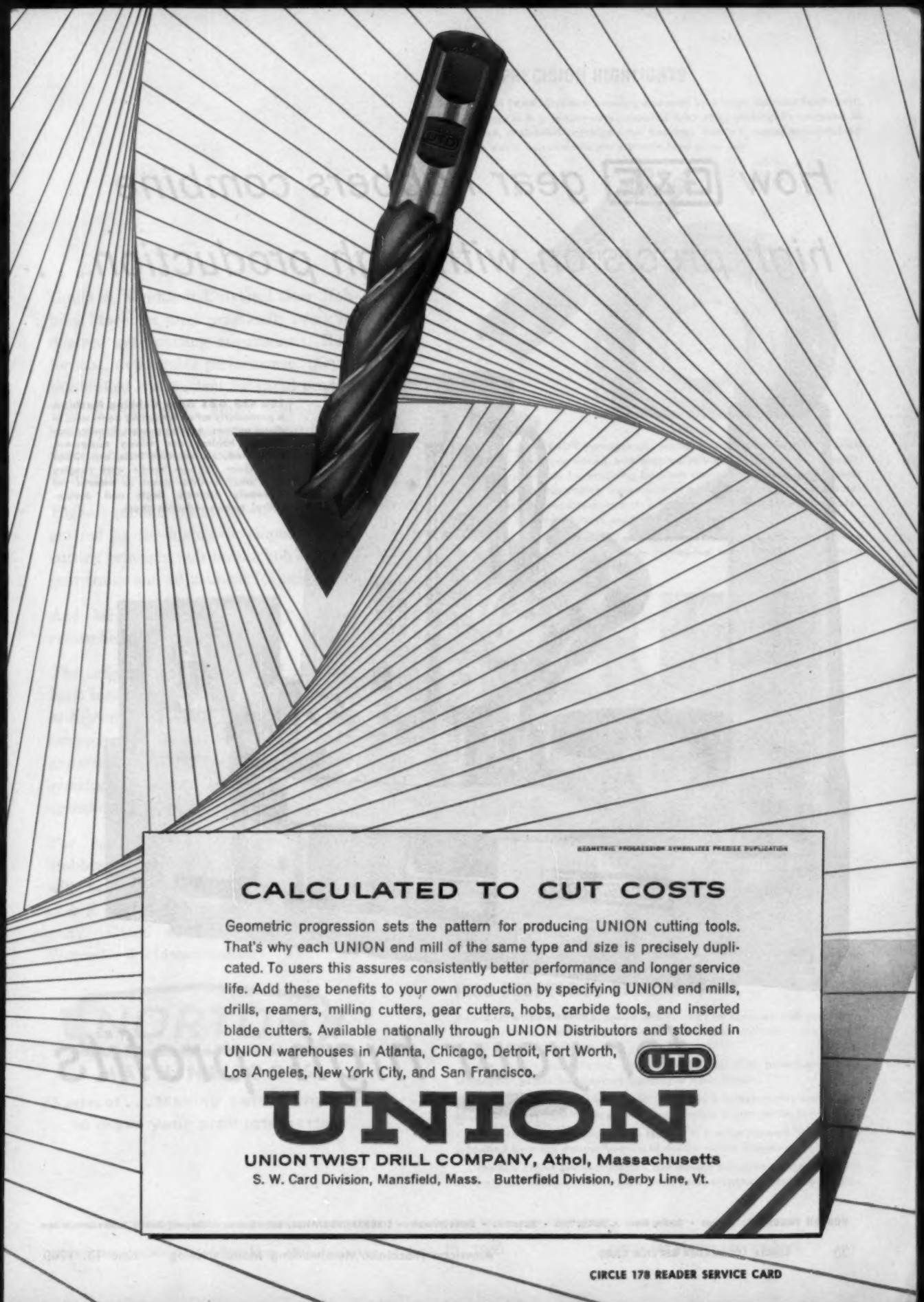
CARD gages, like forms in geometric progression are duplicated with consistent accuracy. Precise duplication like this can help you save production time and money. Get the gages you need from your CARD Distributor, who carries a full line of gages, taps, dies, and screw plates. And get expert advice on their selection and use from your CARD technical man. S. W. CARD DIVISION, Mansfield, Mass. Card Warehouses: Atlanta, Chicago, Detroit, Fort Worth, Los Angeles, New York, San Francisco.

CARD

DIVISION OF UNION TWIST DRILL COMPANY

Serving you through the best distributors from coast to coast

CIRCLE 177 READER SERVICE CARD



GEOMETRIC PROGRESSION SYMBOLIZES PRECISE DUPLICATION

CALCULATED TO CUT COSTS

Geometric progression sets the pattern for producing UNION cutting tools. That's why each UNION end mill of the same type and size is precisely duplicated. To users this assures consistently better performance and longer service life. Add these benefits to your own production by specifying UNION end mills, drills, reamers, milling cutters, gear cutters, hobs, carbide tools, and inserted blade cutters. Available nationally through UNION Distributors and stocked in UNION warehouses in Atlanta, Chicago, Detroit, Fort Worth, Los Angeles, New York City, and San Francisco.

UTD

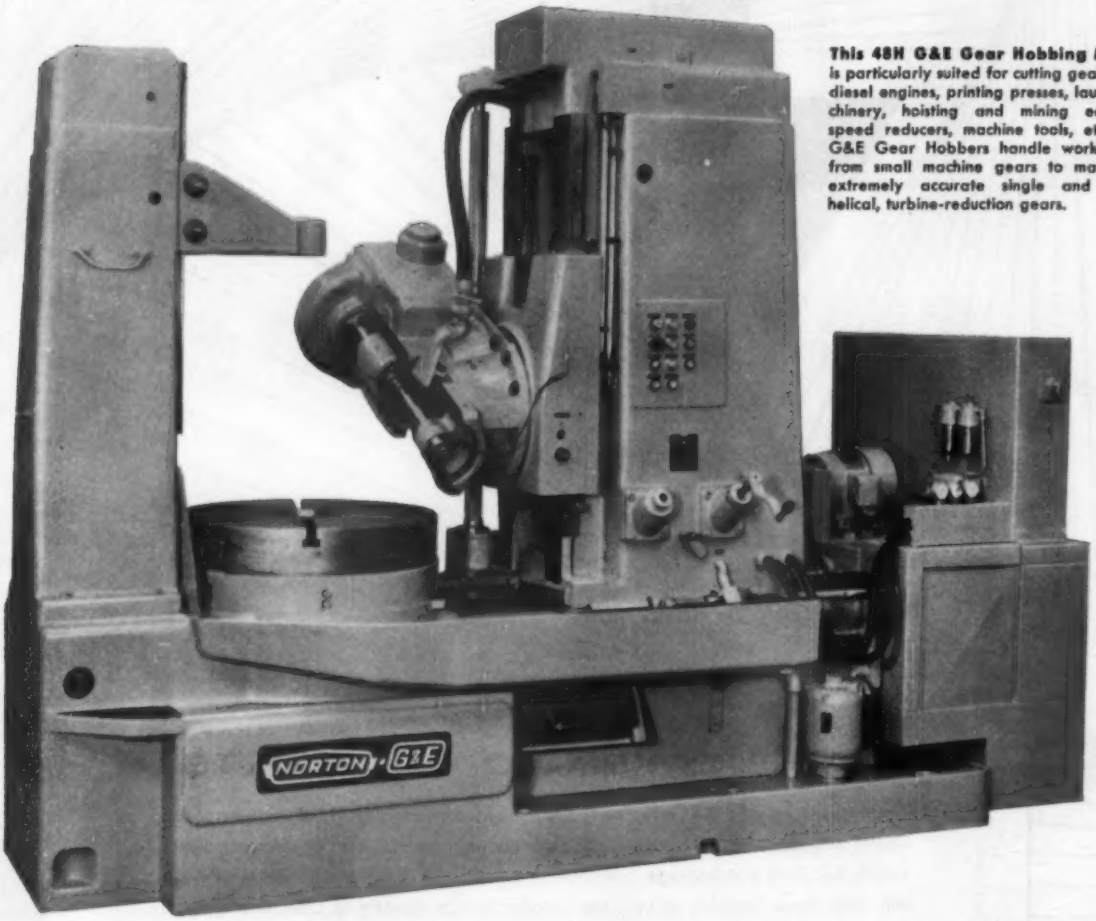
UNION

UNION TWIST DRILL COMPANY, Athol, Massachusetts

S. W. Card Division, Mansfield, Mass. Butterfield Division, Derby Line, Vt.

CIRCLE 178 READER SERVICE CARD

How G&E gear hobbers combine high precision with high production...



This 48H G&E Gear Hobbing Machine is particularly suited for cutting gears used in diesel engines, printing presses, laundry machinery, hoisting and mining equipment, speed reducers, machine tools, etc. Other G&E Gear Hobbers handle work ranging from small machine gears to massive yet extremely accurate single and double-helical, turbine-reduction gears.

for your high profits

NORTON PRODUCTS: Abrasives • Grinding Wheels • Machine Tools • Refractories • Electro-Chemicals — **BEHR-MANNING DIVISION:** Coated Abrasives • Sharpening Stones • Pressure-Sensitive Tapes

Gould & Eberhardt Universal Gear Hobbing Machines meet practically every industrial gear cutting requirement. Built for fast, dependable performance, they're established cost-cutters for rapid production of spur gears, single and double-helical gears, sprockets, splines, worm gears, worms, ratchets and special forms — in a wide range of pitches and diameters.

Highest production at lowest hob cost is assured by the highly developed vertical cutting principle, substantial hob support, gear trains and adjustment features.

And here's a fact it will pay you to remember:

The original productivity and accuracy built into hobbers by G & E is maintained at highest levels — and with every possible advancement — by the assimilation of G & E experience and personnel into the progressive and modern machine tool building operations of Norton Company.

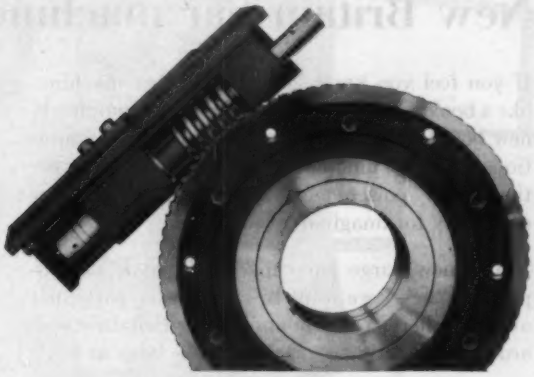
For careful help in selecting Gear Hobbers or other G & E equipment that will benefit your production see your G & E dealer or write to Norton Company, Gould & Eberhardt Division, Worcester 6, Massachusetts.

NORTON
MACHINE TOOLS

75 years of . . . Making better products
. . . to make your products better

HIGH PRECISION HIGHLIGHTS

Vertical Feed. Optimum accuracy is secured by a large diameter feed screw, precision-cut in a temperature-controlled laboratory and rigidly anchored in tapered, preloaded precision roller bearings. Backlash control is maintained by an easily adjusted two-piece bronze feed screw nut.



Indexing. DUALEAD® worm-gearing assures accurate indexing under heaviest production. The worm thread, with progressive variation throughout its length, simplifies adjustment by providing backlash control without change of center distance and insures uniform transmission of motion in both directions of rotations through proper conjugate tooth action, thus maintaining accuracy of index under high operating speeds and over an extended period.

The maximum wear-resistance quality of the mating chill-cast nickel bronze DUALEAD index worm gear results in minimum wear to maintain extreme accuracy longer.

HIGH PRODUCTION HIGHLIGHTS

Rapid, Precise Hobbing. Speed and accuracy for sustained high production rates — as well as extra-long service life of hobs and machines — are assured in G & E Hobbers because:

. . . The heavily proportioned, easily adjusted hob slide travels on double rectangular guides for sustained accuracy in basic motion.

. . . The single-helical final-drive gear to the hob is independently mounted on large antifriction bearings to prevent compounding stresses on the hob spindle.

. . . The fixed-position work table is located in a large tapered bearing and supported by a flat annular bearing to absorb cutting stresses.

. . . The hob arbors are heat treated and chrome plated to reduce wear and eliminate the tendency to raise burrs which cause eccentricity and hob wobble.

MACHINE TOOL DIVISION: Grinding and Lapping Machines — G & E DIVISION: Shapers • Gear Cutting Machines • Gear Induction Hardeners

New, large capacity New Britain bar machines

If you feel you know New Britain bar machines like a book, a word of caution: There's a completely new book! New, basic design that removes limitations formerly inherent in bar machine construction. New power, new speed, completely new capability for imaginative tooling.

And new, large bar capacity. That is the important "new" we want to call to your particular attention here. You can apply New Britain standards of productivity to bar stock as large as 5⅛".

The new, big line of four-, six-, and eight-spindle models:

Model 450. Four spindles, 5⅛" maximum capacity, four independently operated radial cross slides.

Model 635. Six spindles, 3½" capacity, with independent radial cross slide in every position.

Model 826. Eight spindles, 2⅝" capacity. Six independently operated cross slides with the two lower slides exceptionally wide to provide elevating blocks for cross slide tooling in the number 3 and 8 positions.

Inexpensive, disc-type cams provide positive actuation of cross slides. Cross slide and end-working tools on all models are easily accessible. All models have positive spindle carrier lifting, locating and locking. New catalog material will give you further details on these machines. Your New Britain representative can show you how the increased profitability built into them can improve your competitive situation. Plan to see him soon.

THE NEW BRITAIN MACHINE COMPANY

Capacity up to 15" on New Britain chuckers

We are going to take it for granted that *you* take New Britain chuckers for granted—as the leading make of multiple spindle automatics. Most people do. The big news then is that the profitability of these famous machine tools can now be applied to an increased range of work. The new New Britains are available with chucking capacities up to 15", which enables you to apply New Britain standards of speed, accuracy and versatility to larger work.

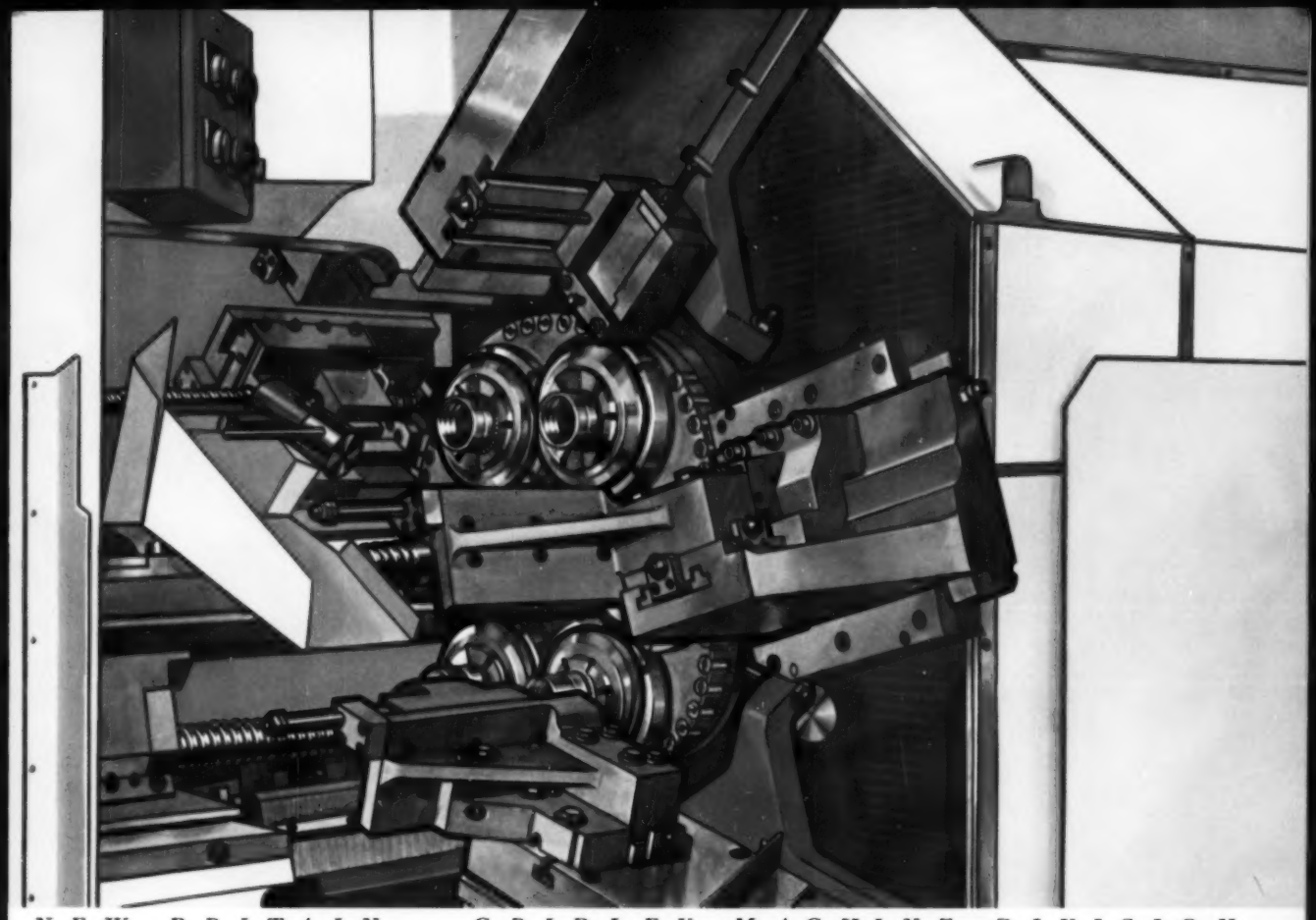
The 15" capacity applies to four-spindle models. Six-spindle machines will take pieces up to 12", and eight-spindle chuckers will handle up to 10".

If you work with large castings and forgings, this might be the announcement of the decade, in terms of an investment that can't fail to be profitable. With equipment like this properly adapted to your particular requirements, nobody, anywhere, is going to trim you on cost per piece.

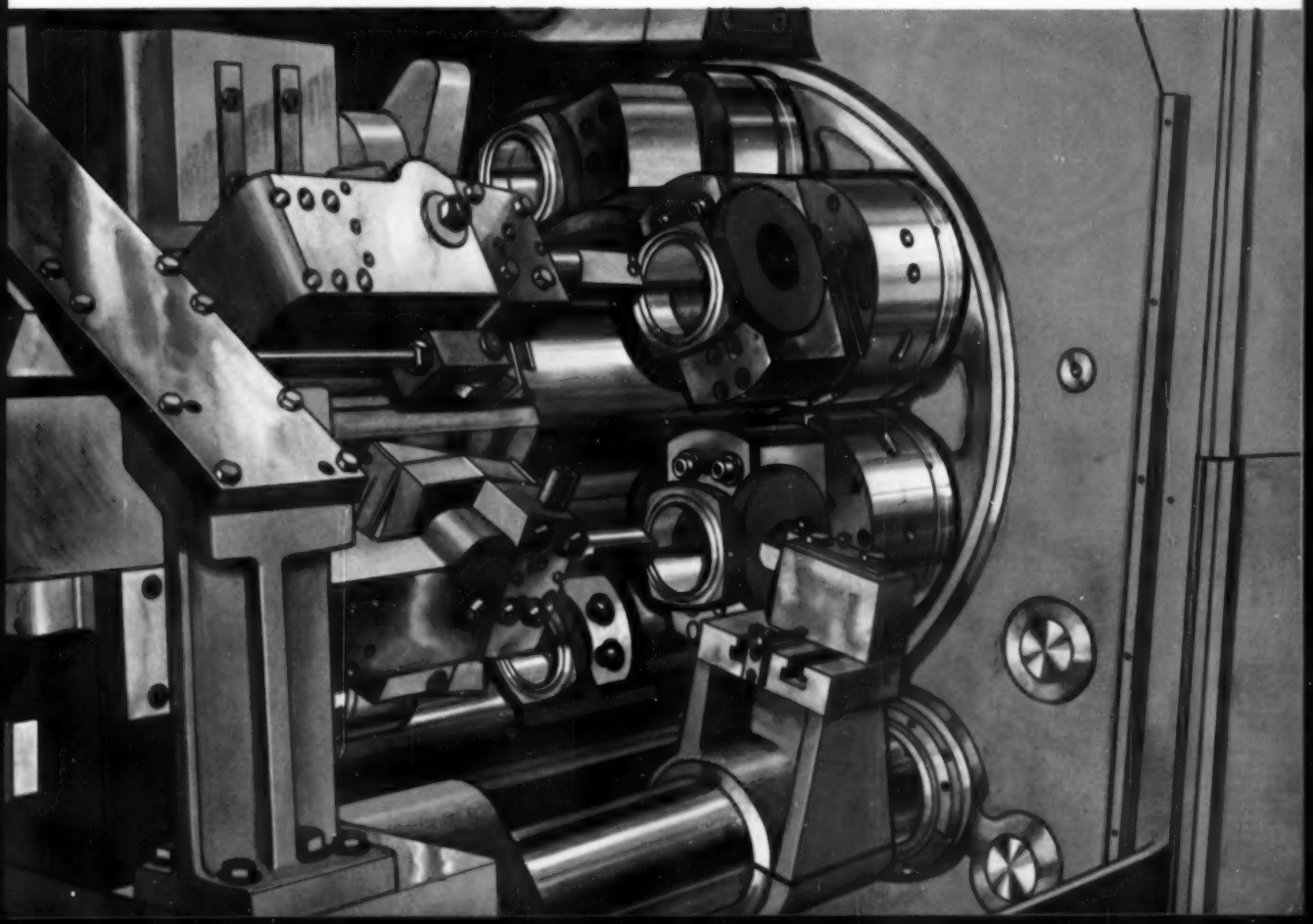
Call on your New Britain sales engineer for practical, specific information, of course. Meanwhile, we have just published a new catalog on these new large capacity chuckers, and we would be happy to mail your copy to you on request. The New Britain Machine Company, New Britain-Gridley Machine Division, New Britain, Conn.

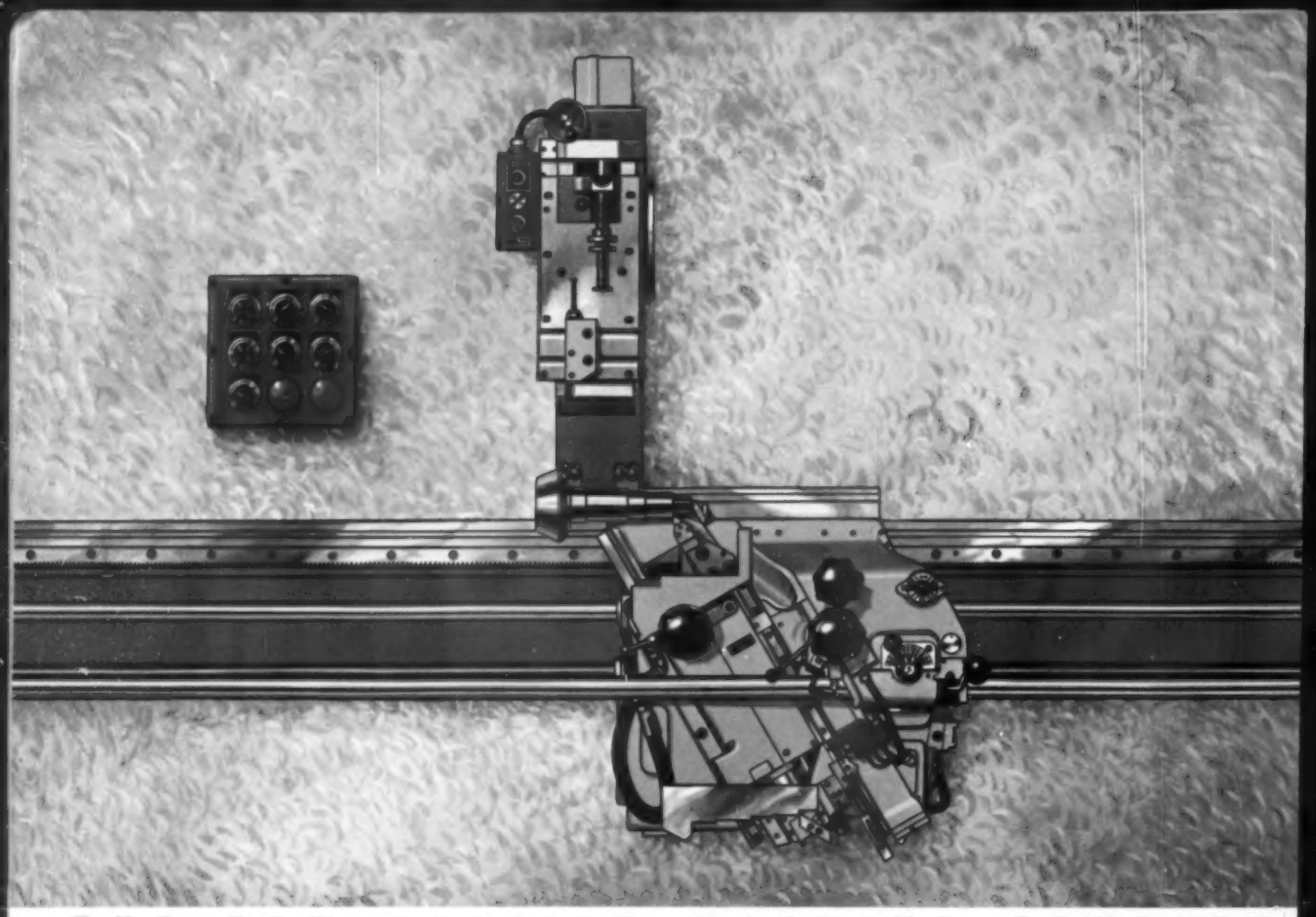
CIRCLE 181 READER SERVICE CARD

CIRCLE 182 READER SERVICE CARD ►

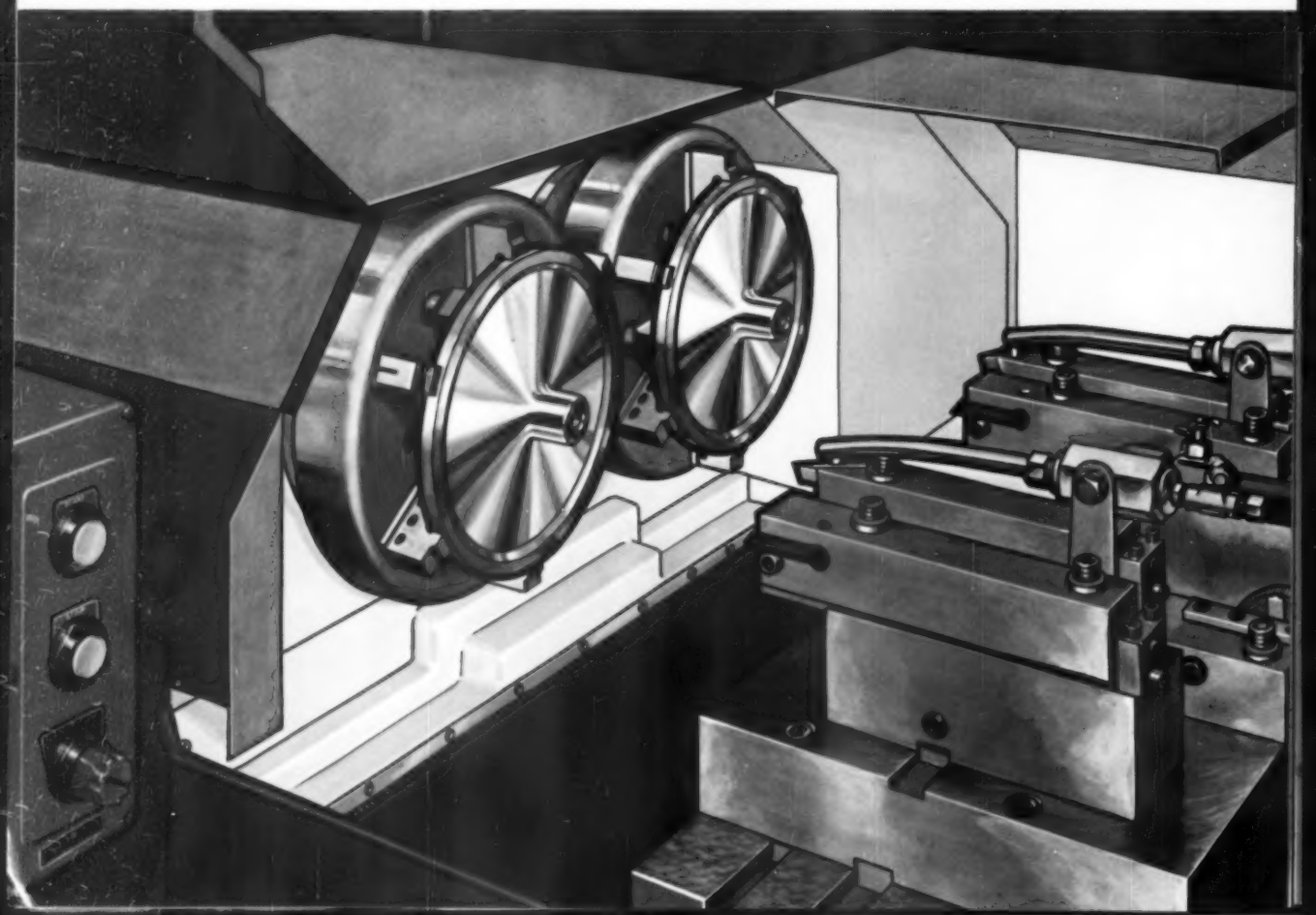


NEW BRITAIN · GRIDLEY MACHINE DIVISION





THE NEW BRITAIN MACHINE COMPANY



Fast, rugged New Britain +GF+ copy lathes

Right from the ground up the New Britain +GF+ is a machine conceived, designed and manufactured as a copying-contouring lathe. Not a standard lathe with copying attachment; not a factory-made "special" with the contouring feature built on components from other lathes; but a solidly based, ruggedly constructed, fast, powerful, accurate machine designed solely for the template-controlled, rapid production of between-centers or chucked work with external or internal contouring.

A million pieces or just a few, it's a machine you'll use on many different types of short-run jobs (just change the template and reset the controls), or on one long-run job (just replace the single-point tool when it wears).

The instantaneously accurate hydraulic copying mechanism is entirely enclosed within the compact carriage. All controls are within easy reach. The template is up front for easy adjustment. The chips fall free into the wide open base, can't clog or jam any part of the mechanism.

There are endless variations available within the New Britain +GF+ line. The standard model has applications anywhere on between-centers or chucked pieces. Other attachments and models are available to suit your particular requirements; infeed attachments, automatic loading, bar stock models, etc.

Don't buy any lathe or "special" for copy turning until you have investigated the New Britain +GF+ copy turning lathe. As a starter, may we send you the latest catalog?

NEW BRITAIN · GRIDLEY MACHINE DIVISION

Consistent accuracy to tenths at super speeds

Model 37 Precision Boring Machine is a machine with a mission, rather than an answer to everybody's metal turning problems. Its mission is contour boring and turning in applications where both extreme repetitive accuracy and high production are of paramount importance. If you have such a requirement, Model 37 is an unbeatable money-maker.

It is an inherently simple machine: simple to operate, with inspection limited to gauging any one dimension. Simple in operating principle, too, built around precision cams that operate without being affected by temperature fluctuation. From one to four high speed spindles can be mounted on a single machine.

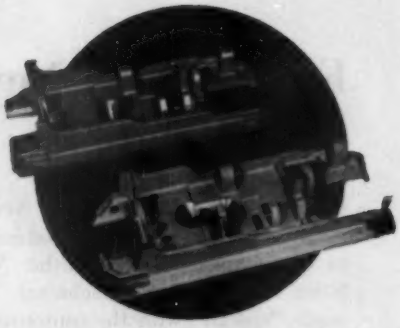
We would be happy to discuss *any* production problem involving straight or contour boring and turning. We doubt that anyone equals New Britain's know-how in this area, and we have a wide variety of boring equipment, both vertical and horizontal and of very advanced design. No matter what your work, or production requirements, this is a very fine place to look for an answer. The New Britain Machine Company, New Britain-Gridley Machine Division, New Britain, Connecticut.

Sub-contracting precision parts, assemblies and machines like these... is our business!

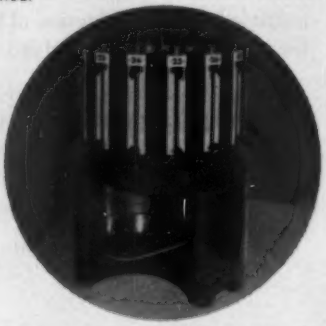
(but we want more of it)

We'd also like to prove to you what our completely integrated manufacturing facilities* can mean to you in terms of lower costs, faster delivery, and complete satisfaction.

TMW's facilities and 65 years' experience in high-precision (tolerances to tenths) manufacturing are available to you *now*, on a short or long-term basis. For details or a new Facilities File Folder, call or write today.



A TMW gray iron casting before and after precise machining, annealing and finishing operations were performed.



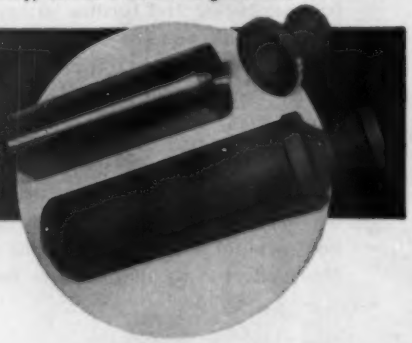
Paint dispenser was economically mass produced for a major manufacturer in TMW's modern shops.

"The world's first and only automatic stud fastener" . . . (another example of TMW precision machining and assembly) carries a LIFETIME guarantee.

* Includes 1,000,000 sq. ft. of manufacturing space, 1200 *modern* machine tools, completely mechanized foundry (one of the world's largest), 3000 skilled craftsmen with a corps of top designers and engineers.

TEXTILE MACHINE WORKS

Contract Division • Reading, Pennsylvania



Jato units, used on the "Honest John" rocket to make it spin, are machined to ±.0002" tolerances and hydrostatically tested to meet strict government specifications.

CIRCLE 185 READER SERVICE CARD

CIRCLE 186 READER SERVICE CARD ►

When you talk about the

***BETTER* MACHINE TOOLS**

you'll talk about

KING

VERTICAL BORING AND TURNING MACHINES

ELMES

HYDRAULIC PRESSES AND EQUIPMENT

for Metalworking, Plastics Molding, Custom-designed Applications.

American Steel Foundries **ELMES/KING DIVISION,** Cincinnati 29, Ohio

NEW TOOL STEEL SERVICE

simplifies purchasing (and saves money, too)

Buying assorted brands of tool steel creates costly paperwork for your . . .

purchasing and receiving departments — manufacturing and accounting, too.

With Crucible's new Tool Steel Service you cut these costs substantially

because you buy fewer grades of tool steels to do more jobs . . .

eliminate piles of paperwork throughout your plant . . .

carry fewer pounds in stock (reduce chances of inventory "mix-ups"), and . . .

pay a lower price per pound (by eliminating costs for small quantity "extras").

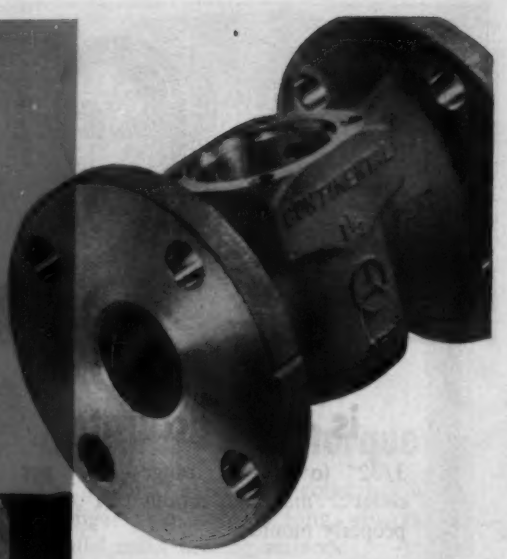
For the full story, call in a CRUCIBLE Service Engineer.

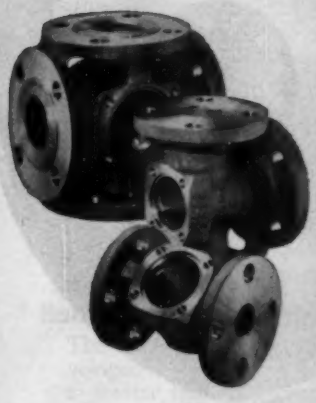
CRUCIBLE STEEL COMPANY OF AMERICA

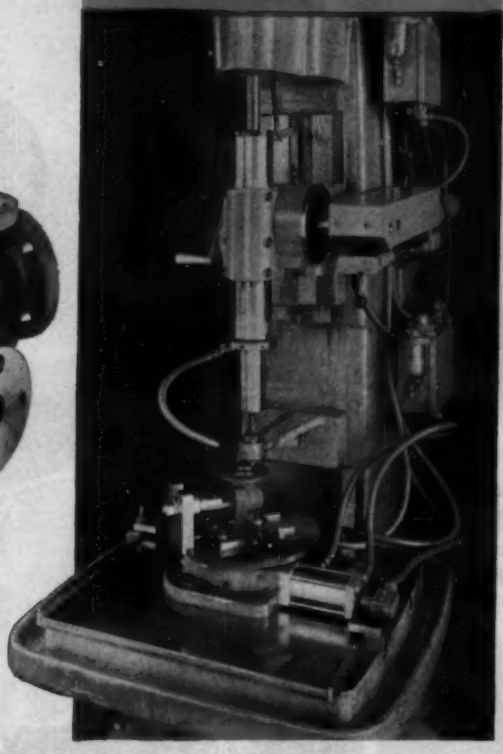
Branch Offices and Warehouses: Atlanta • Baltimore • Boston • Buffalo • Caldwell, N. J. • Charlotte • Chicago • Cincinnati • Cleveland • Columbus • Dallas • Dayton Denver • Detroit • Erie, Pa. • Grand Rapids • Houston • Indianapolis • Los Angeles • Miami • Milwaukee • Minneapolis • New Haven • New York • Philadelphia Pittsburgh • Portland, Ore. • Providence • Rockford • Salt Lake City • San Francisco • Seattle • Springfield, Mass. • St. Louis • E. Syracuse • Tampa • Toledo • Tulsa
CRUCIBLE STEEL OF CANADA, LTD., SOREL, QUEBEC, CANADA

HERE'S DRILLING AUTOMATION ...dirt cheap!

In this case, on valve body flanges*







Problem: "On this Continental Manufacturing job, we have various valve body sizes in tough-machining materials, hole diameters to ¾", and small lot runs up to 25 pieces. To make it a profitable operation, we must have low-cost equipment with fast setups for quick changeovers."

Answer: Standard 21" CINCINNATI, "tailored" with standard air-operated feed and table indexing . . . simple, flexible fixturing for approximately 5 minutes setup time . . . 2½ to 5 minutes cycle time depending on material . . . total equipment cost slightly under $4000!

Let Cincinnati Lathe and Tool service engineers tailor a versatile new CINCINNATI Drilling Machine *to suit your needs exactly!* You get a specialized unit made with the right combination of standard accessories—the most practical approach to LOWEST COST PER DRILLED HOLE!

The story of another of many shops, large and small, who have brought their drilling problems to our service engineers for help. Ask your Cincinnati Lathe and Tool Dealer for service engineering on your drilling problem. If you can't reach him immediately, wire us—collect!

cincinnati lathe and tool co.

Cincinnati 9, Ohio

HYDRASHIFT Lathes • CINCINNATI Drilling Machines
SPIROPOINT Drill Sharpeners

NEW TOOL STEEL SERVICE

simplifies purchasing (and saves money, too)

Buying assorted brands of tool steel creates costly paperwork for your . . .

purchasing and receiving departments — manufacturing and accounting, too.

With Crucible's new Tool Steel Service you cut these costs substantially

because you buy fewer grades of tool steels to do more jobs . . .

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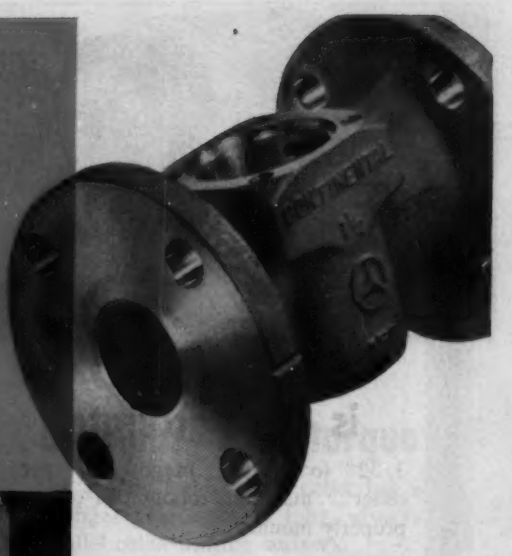
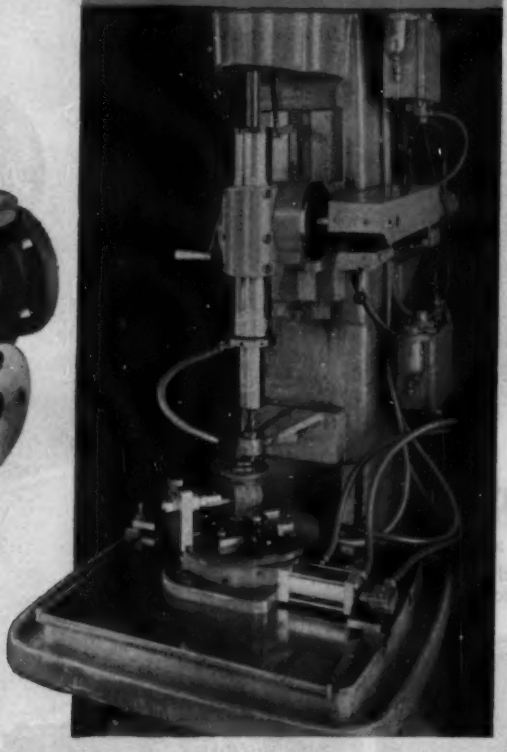
In this case, on valve body flanges*





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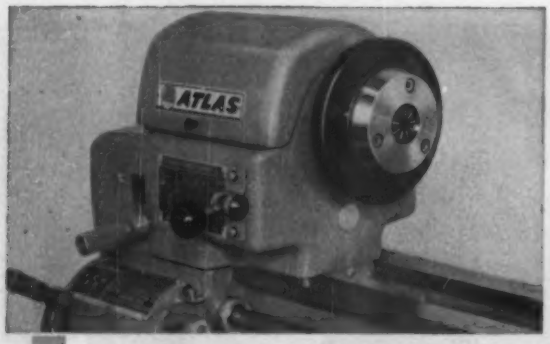
cincinnati lathe and tool co.

Cincinnati 9, Ohio

HYDRASHIFT Lathes • CINCINNATI Drilling Machines
SPIROPOINT Drill Sharpeners

New MODEL 50 collet chuck equips a lot more

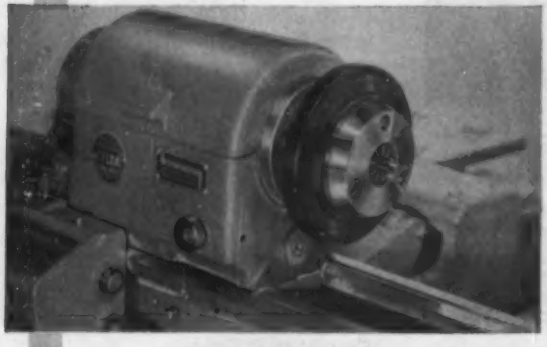


Model 50 is more accurate

3/32" to 1-1/16" range—.100" per collet . . . maximum runout .001", when properly mounted.

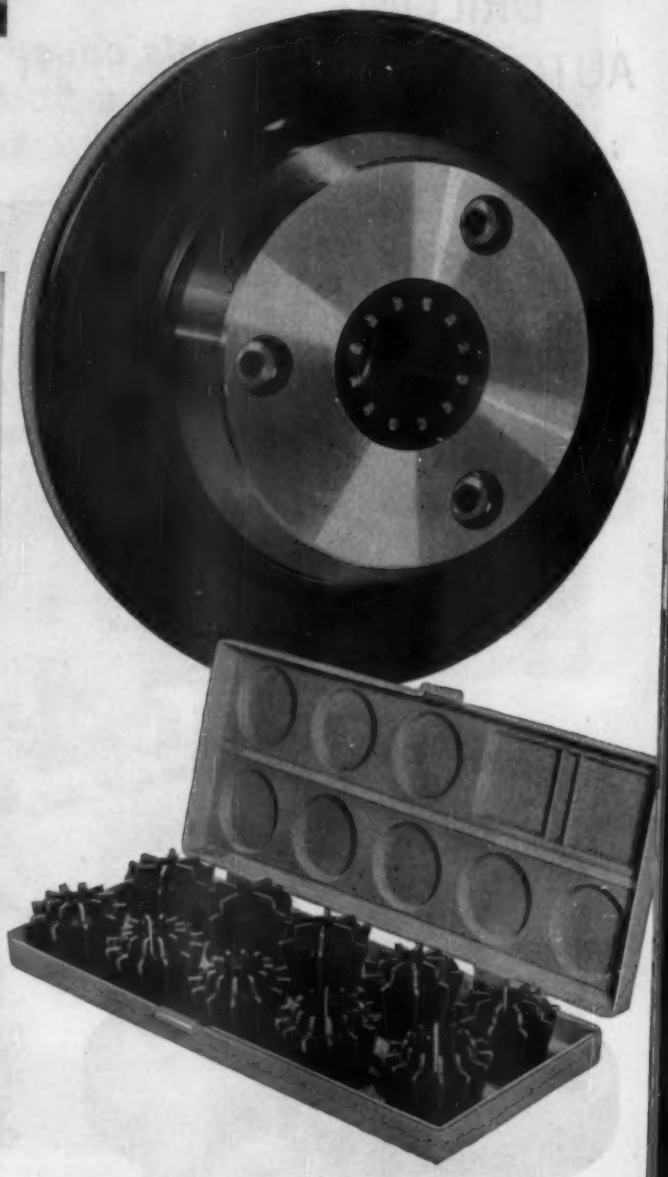
Model 50 is easier to operate

All opening and closing is done at the spindle nose. Rubber-Flex collet changing is quick and easy.



Model 50 increases lathe capacity

No draw bar needed. The full diameter of the spindle through hole is available for chucking larger sizes.



$70.00 for the chuck

$65.00 for the collets

world's most modern your lathes to do for a lot less!

Atlas, Clausing, Delta, Logan, Sheldon, and South Bend lathes and others of similar power and capacity now give top performance when equipped with the new Jacobs Model 50. Improve performance of your lathes. Increase spindle capacity as much as 42%. Get greater accuracy and stronger grip. It's easy and inexpensive with new Model 50 and its companion Rubber-Flex collets.

CONSIDER THESE FEATURES . . .

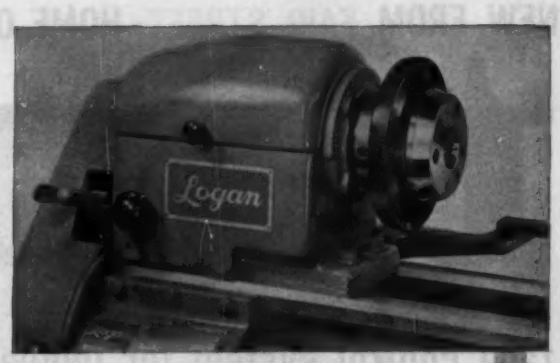
- **Gripping Power**
  Model 50 is made for heavy duty turning. It has tremendous gripping power.
- **Accuracy**
  Model 50 is factory tested—maximum runout .001" T.I.R. at the nose, when properly mounted.
- **Thin Walled and Fragile Work**
  Always parallel Model 50 Rubber-Flex collet jaws permit chucking of tubing and fragile materials without crimping or scoring.
- **Range**
  The 10 Rubber-Flex collets in the 500 Series, developed especially for use with Model 50, cover a greater bar stock range than 63 old-fashioned steel collets. You can chuck any bar between 3/32" and 1-1/16" with this set of 10 collets.
- **Capacity**
  Model 50 eliminates capacity-wasting draw bar. You can increase spindle capacity up to 42%.
- **Adapters**
  Model 50 adapters are fully machined for immediate mounting. Available in all popular threads and American Standard L00 taper.
- **Price**
  Model 50 prices are revolutionary!
  $70.00 for the chuck.
  $65.00 for the complete set of 10 collets.

MODERNIZE YOUR LATHES WITH JACOBS MODEL 50 AND RUBBER-FLEX COLLETS. YOU CAN'T AFFORD NOT TO!

See your Jacobs industrial supply distributor. Give him the opportunity to prove these fantastic facts with a convincing demonstration at your desk! Call him today.

Jacobs CHUCKS

The Jacobs Manufacturing Co., West Hartford 10, Conn.



Model 50 develops more torque

The Jacobs Rubber-Flex collet has a stronger grip . . . extra long, always parallel collet bearing surfaces.

Model 50 mounts directly on spindle

Model 50 is furnished with mounted adapter. No threading necessary.

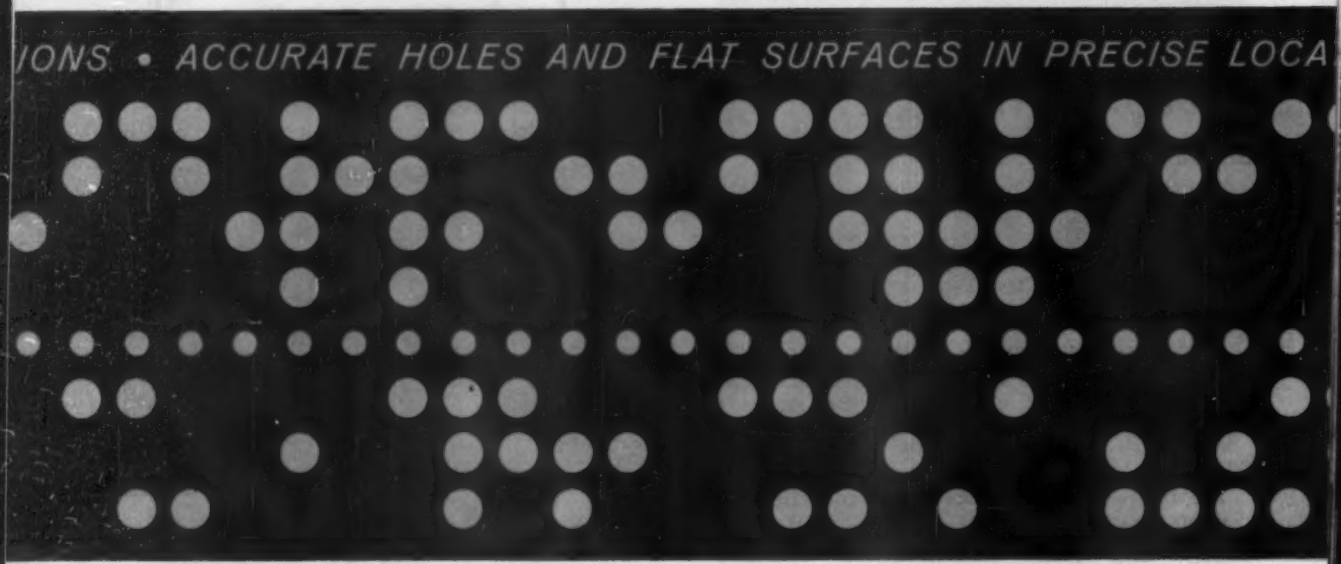
Model 50 is quicker to operate

Handwheel makes chuck easy to open and close. Hex wrench locks fast and easy at the nose.

NEW FROM FAIR STREET • HOME OF THE JIGMIL

tapac*

tape control system for DeVlieg Spiramatic Jigmils®



Now available for automatic programming of all Spiramatic JIGMILS, Tapac is DeVlieg's own system of numerical control. And it is so simplified, a tool engineer can master the programming technique in 3 to 4 hours.

Designed to make full use of JIGMIL'S inherent accuracy and precision, Tapac is a point-to-point system for automatic measuring, positioning and cycling complete parts programs utilizing 1" eight-channel standard punched tape input. Automatic functions include sequential or simultaneous positioning of vertical and horizontal slides, spindle depth control cycling and control of spindle speeds and feeds. *Automatic positioning repeats to within 0.0001".* The control system is comprised of simple plug-in electronics and standard proven components.

Come to Fair Street and see the Tapac system of automatic tape control for jigless boring and machining in our own production operations. Its accuracy, precision and flexibility will work equally well for you.

*Trademark—De Vlieg Machine Company

Rewarding revelations in automatic precision await your next visit to Fair Street

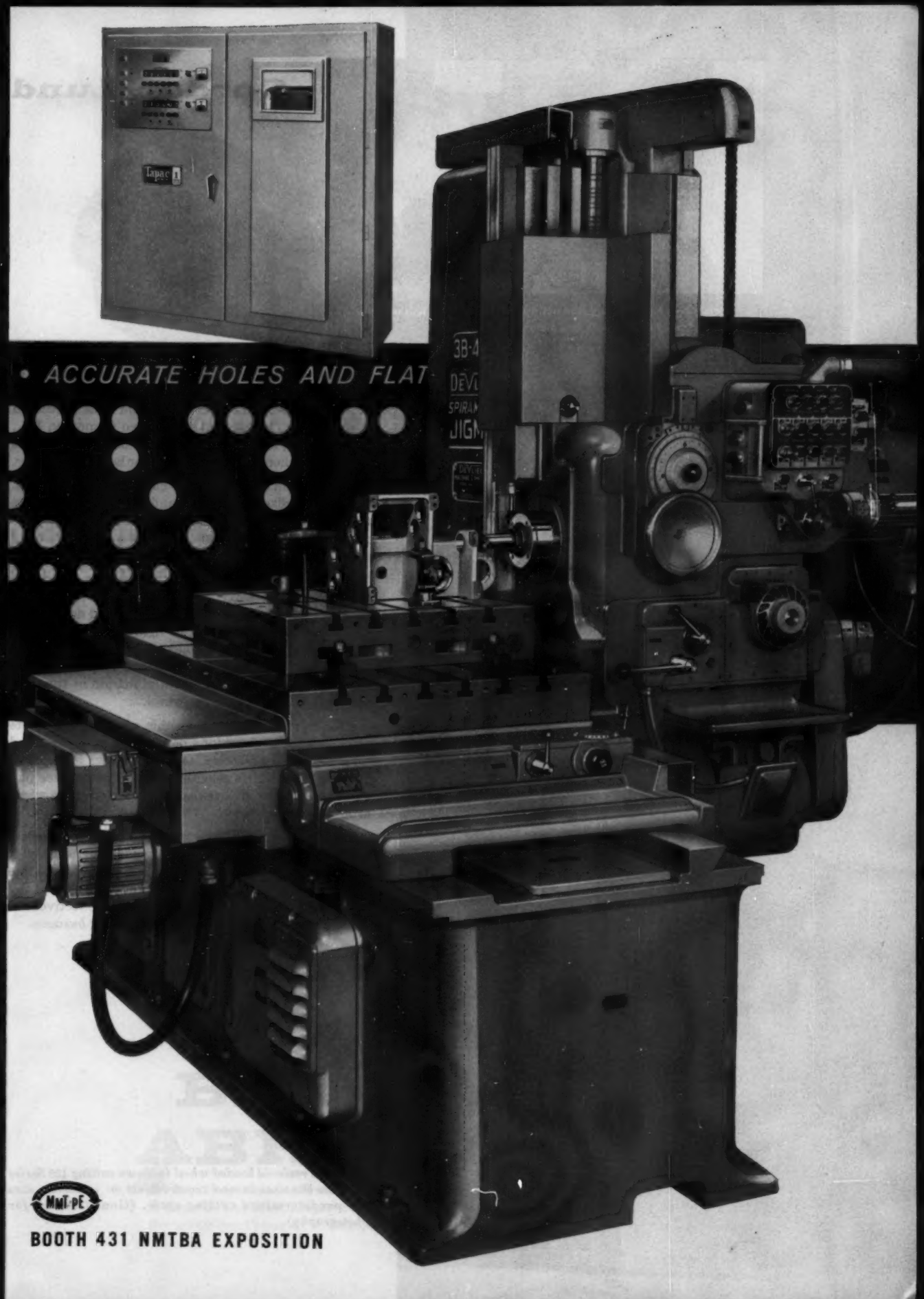
DeVlieg

SPIRAMATIC JIGMILS®

ACCURATE HOLES AND FLAT SURFACES IN PRECISE LOCATIONS

DE VLIEG MACHINE COMPANY, FAIR STREET • ROYAL OAK, MICHIGAN

CIRCLE 191 READER SERVICE CARD


• ACCURATE HOLES AND FLAT
MMT·PE
BOOTH 431 NMTBA EXPOSITION

Gordon Lund

Purchasing Agent Harold Hammel discusses quality of finished cut on stainless bar stock with Bay State's Gordon Lund.

Cost is a vital consideration in the manufacturing of components for modern steam power and heating installations. And one of the largest and most successful manufacturers in this field is the Sarco Company, Inc., of Bethlehem, Pa. Their Thermo-Dynamic steam traps are famous wherever steam is used for heating or power.

The problem at Sarco was to cut square and octagon bar stock to size for the trap and keeping costs down was vitally important. At the direction of Sarco Purchasing Agent Harold Hammel, tests were run on band and hack-saw cutting as well as on the best available abrasive cut-off wheels.

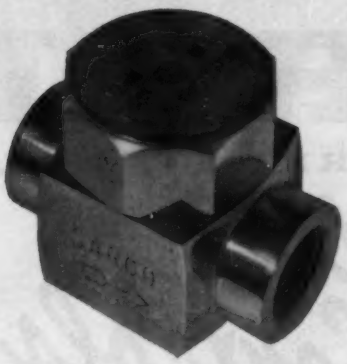
Bay State Abrasive Specialist Gordon Lund was asked to specify the wheel he figured would do the best job and results proved that he figured right. Not only were cut-off wheels in general 15-20% more economical than sawing but Bay State's resinoid bonded wheel beat other wheels by a substantial margin in time per cut and number of cuts per wheel.

Even more important than this, after the Bay State wheels had been in use for a period of time, Sarco rated them *tops for consistency*, too . . . another example of the way Bay State's relentless testing procedures pay off in wheels that give the same top performance wheel after wheel after wheel.

Like Gordon Lund, your own Bay State representative brings you the advantages of wide experience with grinding problems of all types . . . plus a complete line of high-performance abrasive products backed by research and test programs of unequalled effectiveness. *Better grinding at lower cost . . . that is our business.*

Bay State resinoid bonded wheel is shown cutting 420 Series stainless bar stock to meet requirements for maximum cuts per predetermined cutting cycle. (Guard raised for photography).

helped lower stainless cutting costs 15-20% at SARCO



Four years of bare-knuckles shop experience with a major automobile manufacturer plus six years experience as an Abrasive Specialist (both in-plant and in the field) give Gordon Lund an unusually broad knowledge of the metal-working industry in general and grinding techniques in particular.

BAY STATE ABRASIVES

BAY STATE WHEELS of PROGRESS

Bay State Abrasive Products Co., Westboro, Massachusetts.
In Canada: Bay State Abrasive Products Co., (Canada) Ltd., Brantford, Ontario.
Branch Offices: Chicago, Cleveland, Detroit, Los Angeles, Pittsburgh. *Distributors:* All principal cities.

CIRCLE 194 READER SERVICE CARD

BULLARD

DYNATROL*

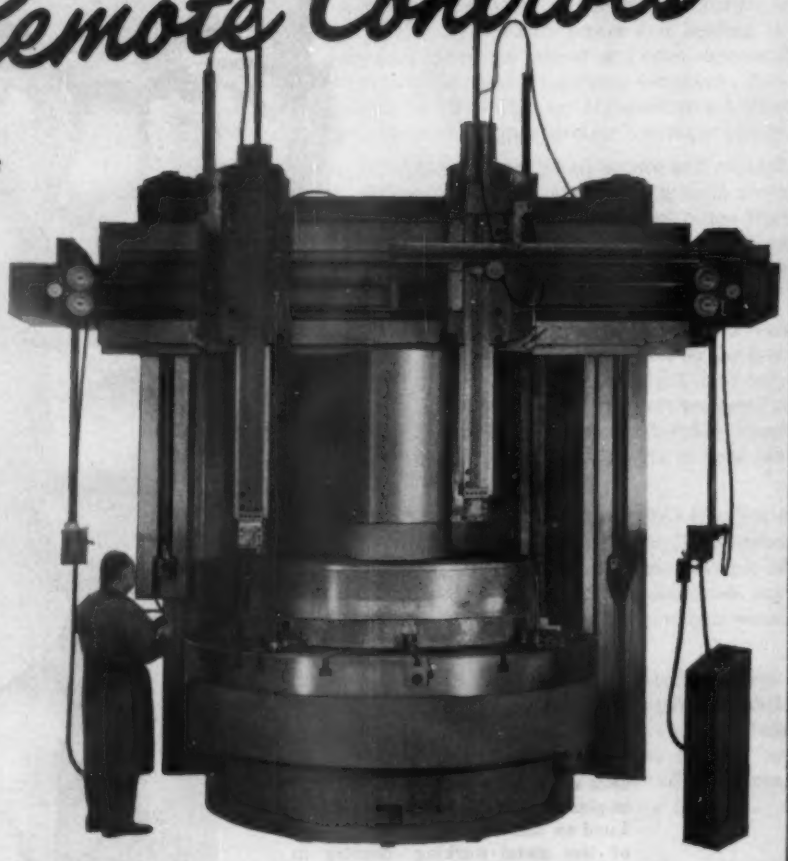
VERTICAL BORING AND TURNING MILLS

FEATURE *Simplified Remote Controls*

Within the span of a man's hand, utilizing a stationary and portable pendant, are all the controls necessary to actuate these modern giant mills. No climbing or clamoring for buttons or levers – every function of the machine is controlled from a position most advantageous to the operator.

The stationary pendant controls feed rate, table speed, starting and stopping of the table – also table jogging.

The portable pendant controls direction of heads in traverse or feed for either horizontal, vertical or 45° travel.



108" Dynatrol Vertical Boring and Turning Mill
Capacity – Maximum swing 120"; Height under rail – 80"; Ram travel – 60"; Ta
speed ranges, optional, Low 1.4 to 50; Int. 2.1 to 75; High 2.8 to 100; Feed rates infinit
variable from 0-500; available with Plain Table, or 4-jaw independent built in chu

This control system, and other revolutionary new Dynatrol features, enable the operator to utilize modern cutting tools at maximum speeds – cut to closer tolerances with superior finish – remove more metal per hour and keep the tool in the cut for more hours per shift. Table diameters of sizes 92, 108, 124 and 144 inches are available. Write or telephone for detailed catalog and complete information. The Bullard Company, Bridgeport 9, Conn., telephone Edison 6-2511.

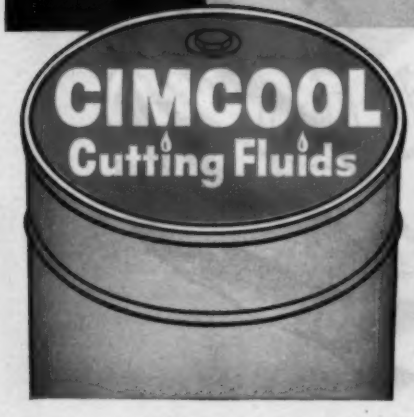
* Trade Mark

. . . YOU CAN'T BEAT A BULLARD . .

FLEXIBILITY--plus rust control!

Here's the latest on-the-job report on CIMCOOL, the world's largest-selling chemical cutting fluid! (Company name on request.)

SALES REPORT
2.
make air compressor and pneumatic equipment, working mostly on cast, ductile and malleable iron.
Cimcool S2 with Cimplus completely solved bad rust problems they once had. For 10 years they've used Cimcool at dilutions from 1:15 to 1:80 and get perfect cutting action and rust control.
They pre-mix at central control points within each department. They like Cimcool's flexibility, because they can get the specific dilution a particular operation calls for.
Herb Whitacre
Cleveland Office



FOR 100% OF ALL METAL CUTTING JOBS

Production-proved products of The Cincinnati Milling Machine Co.

CIMCOOL S2 Concentrate — The pink fluid which covers 85% of all metal cutting jobs.
CIMPERIAL® — Newest in the famous, industry-proven line of CIMCOOL® Cutting Fluids.
CIMPLUS — The transparent grinding fluid which provides exceptional rust control.
CIMCUT Concentrates (AA, NC, SS) — For every job requiring an oil-base cutting fluid.
ALSO — CIMCOOL Tapping Compound — CIMCOOL Bactericide — CIMCOOL Machine Cleaner.

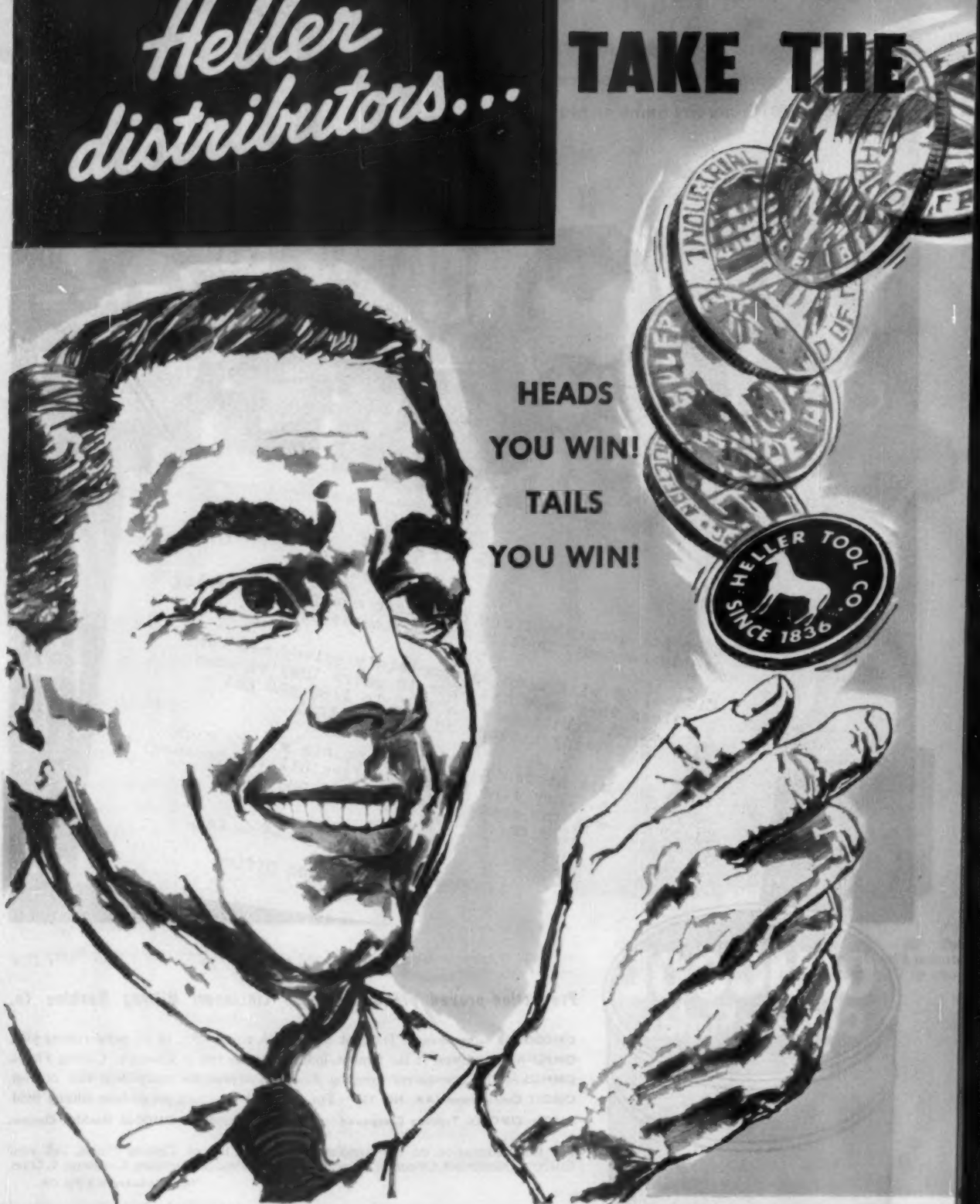
For full information on the complete family of CIMCOOL Cutting Fluids, call your CIMCOOL Distributor. Or contact Cincinnati Milling Products Division, Cincinnati 9, Ohio.

*Trade Marks Reg. U. S. Pat. Off.

◄ CIRCLE 195 READER SERVICE CARD

CIRCLE 196 READER SERVICE CARD

Heller distributors... TAKE THE



GAMBLE OUT OF BUYING!

You know them! Located only minutes away . . . even closer by phone . . . they put your problems and interests first . . . spending their time saving yours . . . tailoring their stocks to fit your needs . . . tying up their money to keep yours free . . . matching their deliveries to your demands . . . worrying about product quality so you won't have to. They're never satisfied unless you are.

You need them! They're as valuable to your firm as a supermarket is to your family. As the local source of diversified national brands, they have already done your shopping for you . . . shortening the distance between leading suppliers and you . . . placing nationwide experience and resources at your command . . . providing the values you need to compete in today's market.

You always win when you call them! Whether you order by name, brand or number, you get the quality you expect . . . at the right price . . . on time. Yes, you always win . . . never lose . . . when you buy through your INDUSTRIAL SUPPLY DISTRIBUTORS. And, of course, if you "Holler for Heller", you're doubly sure of taking the gamble out of buying.

Heller
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FILES • HACK SAW BLADES • BAND SAWS • DIE STEEL • HAMMERS

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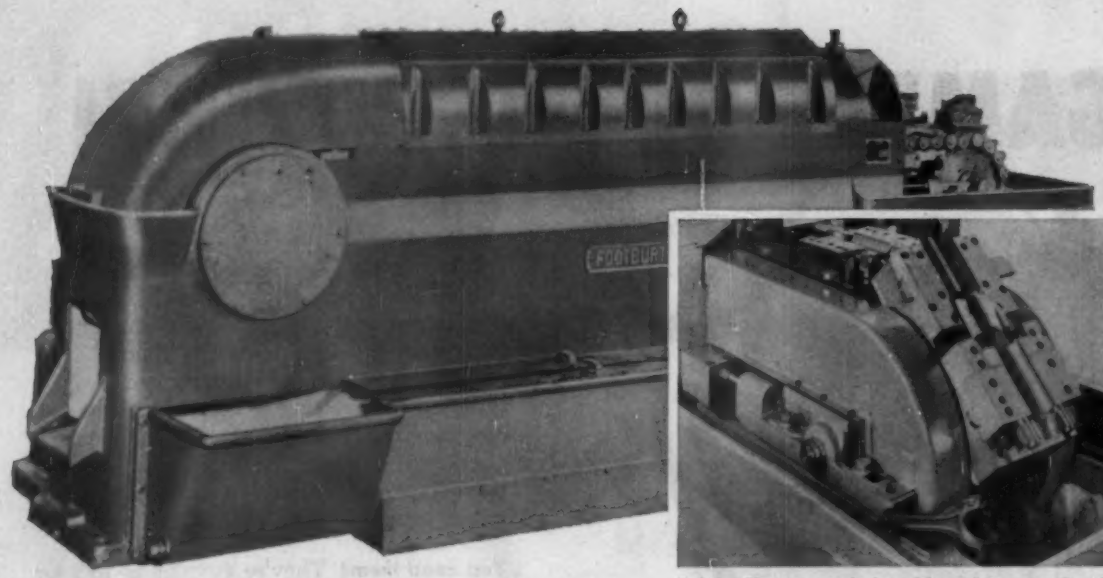
America's Oldest File Manufacturer
NEWCOMERSTOWN, OHIO
Subsidiary of Simonds Saw and Steel Co.

17-0-4

ENGINEERED FOR PRODUCTION

Continuous type broaching machine built in five sizes.



Holding Fixtures are designed for quick, convenient loading, with automatic clamping, unclamping and unloading.

Surface broaching

means high production plus accuracy

Surface Broaching is a modern machining method that in many cases shows reduced costs through higher production, finish to closer tolerance, and low tool maintenance costs. If you machine large quantities of duplicate parts we will be glad to work with you on the possibility of adopting Footburt Surface Broaching Machines. Send us blueprints and hourly production requirements for our recommendations.

THE FOOTE-BURT COMPANY CLEVELAND 8, OHIO

Detroit Office: 24632 Northwestern Highway, Detroit 35, Mich.

..... Write for Circular 503

FOOTBURT

PIONEERS IN SURFACE BROACHING

The "Touch of Gold" applied on a grand scale to barrel finishing

A giant size barrel and Norton TUMBLEX* abrasive reduce the cost of putting the finishing touch on these aircraft spars.

Barrel finishing with Norton TUMBLEX* abrasive is finding more and more applications because it performs this function better, faster, and for less money than other methods.

Norton brings this value-adding, profit-increasing "Touch of Gold" to industry in the widest variety of tumbling operations . . . using six types of TUMBLEX* abrasive, each in a variety of sizes, on parts ranging from tiny needles to these seven foot spars.

Send in your parts to our Sample Processing Department. We will finish them using the correct abrasive and send you a detailed report on methods and equipment. Send your parts to NORTON COMPANY, General Offices, Worcester 6, Massachusetts.

*Trade-Mark Reg. U.S. Pat. Off. and Foreign Countries

NORTON
ABRASIVES

75 years of . . . Making better products . . . to make your products better

NORTON PRODUCTS: Abrasives • Grinding Wheels • Machine Tools • Refractories • Electro-Chemicals — **BEHR-MANNING DIVISION:** Coated Abrasives • Sharpening Stones • Pressure-Sensitive Tapes

FOR MAXIMUM AVAILABILITY SPECIFY

B&W *Job-Matched seamless mechanical tubing*

B&W offers you . . .

- a wide choice of tube diameters, wall thicknesses and lengths
- a broad range of standard and special analyses in carbon or alloy steels
- a complete variety of tube finishes — hot-finished, turned, cold-drawn or roto-rocked
- service from 2 tube mills—plus a nationwide network of district sales offices and steel service centers manned by *experienced* tube salesmen—ready to serve you *promptly*

These are just a few of the many reasons why it pays to specify B&W Job-Matched Seamless Mechanical Tubing. And remember—matching tubes to jobs assures you the *right tube,* in the *right quantity,* at the *right time.* For more information, call your local B&W District Sales Office, or write for Bulletin TB-430. The Babcock & Wilcox Company, Tubular Products Division, Beaver Falls, Pennsylvania.

TA-9047-SM1

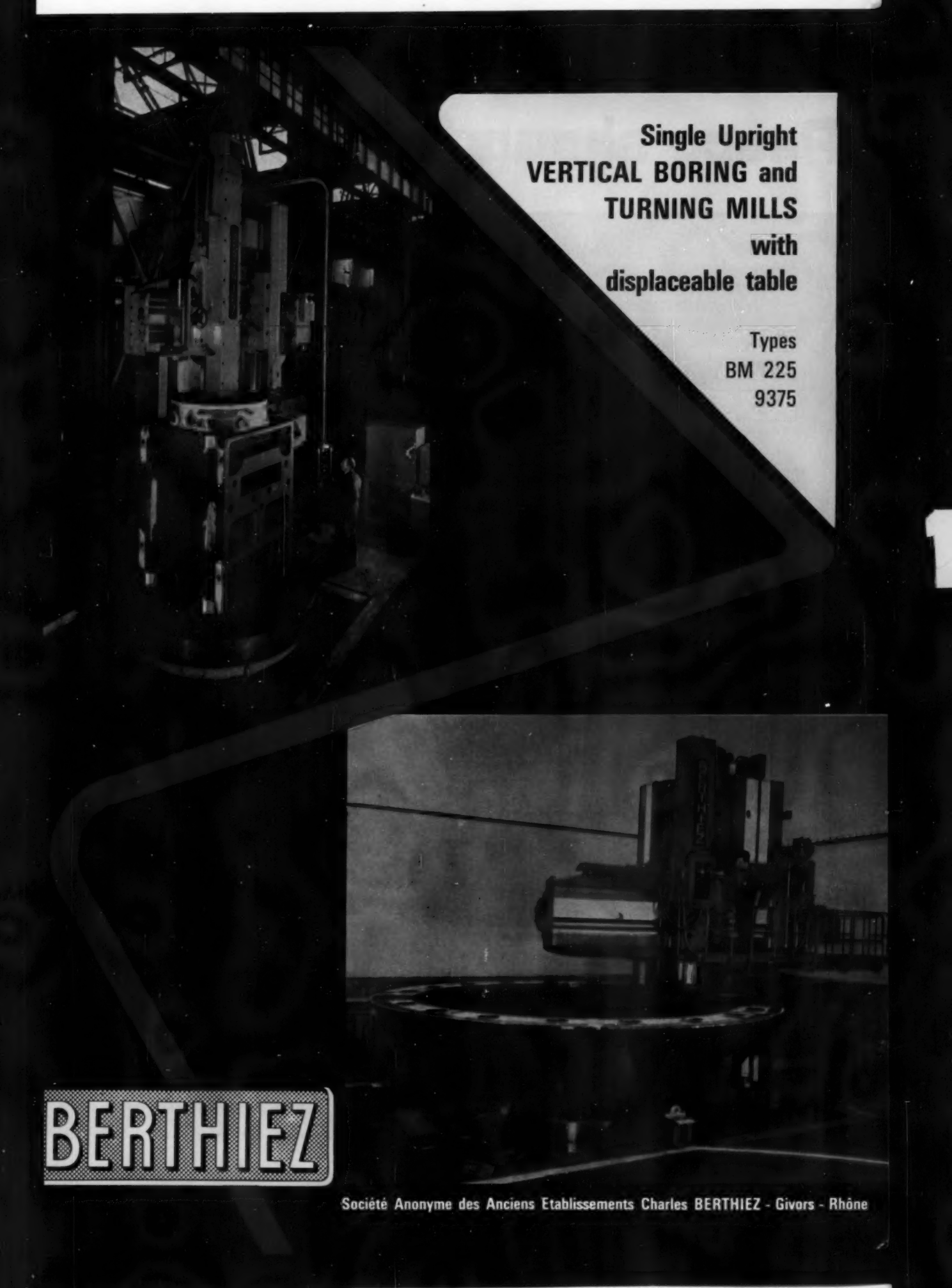
B&W THE BABCOCK & WILCOX COMPANY

TUBULAR PRODUCTS DIVISION

Seamless and welded tubular products, solid extrusions, seamless welding fittings and forged steel flanges—in carbon, alloy and stainless steels and special metals

CIRCLE 201 READER SERVICE CARD

CIRCLE 202 READER SERVICE CARD ►



Single Upright
VERTICAL BORING and
TURNING MILLS
with
displaceable table

Types
BM 225
9375

BERTHIEZ

Société Anonyme des Anciens Etablissements Charles BERTHIEZ - Givors - Rhône

Pesco shows $11,735 saving

One of a battery of furnaces which performs critical heat treating operations at Pesco Products Division. Vertical-shaft bearings were failing in spite of daily lubrication. Mobil recommended correct grease . . . lengthened lube intervals to two weeks . . . eliminated bearing failures. Pesco saved $4,295 in 20 months.

Mobil Correct

with Mobil Program

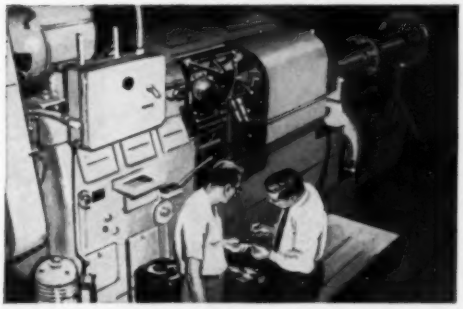
At Borg-Warner Corporation's Pesco Products Division, Mobil helps cut maintenance costs, increase production

Pesco Products ranks with the nation's foremost suppliers of components and systems for aircraft and space-vehicles . . . must maintain exacting product reliability and rigid schedules. To help meet these critical requirements, Pesco turned to a Mobil Program of Correct Lubrication.

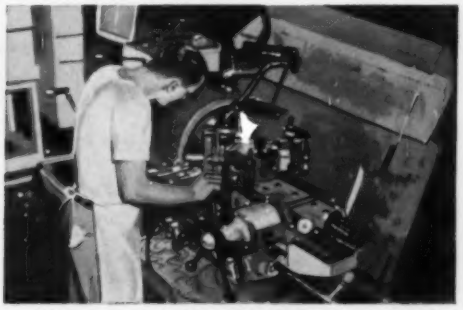
Mobil engineers began a program of analysis and study of Pesco maintenance and lubrication procedures in cooperation with Pesco personnel. The improved methods, schedules, and recommendations that resulted brought Pesco maintenance to a new standard of efficiency and economy. Special areas of assistance by Mobil included instruction of maintenance crews, lubrication charts and recommendations, and problem-solving in high-cost areas. In 20 months, the Mobil Program saved Pesco $11,735.

To find out how a Mobil Program may benefit *your* plant, write for an informative brochure. Or call your local Mobil representative.

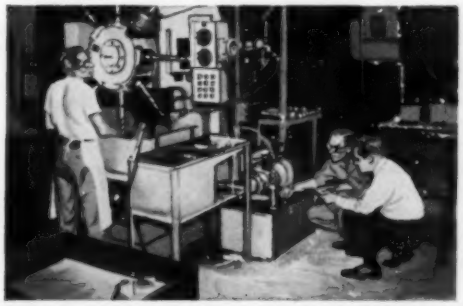
MOBIL OIL COMPANY
150 East 42nd Street, New York 17, N. Y.



1. Sticking clutch plates on automatic screw machines posed costly maintenance problem for Pesco. Mobil traced the trouble to the oil used for machine lubrication . . . supplied a dual purpose fluid that eliminated the clutch problem, prevented loss of the cutting oil effectiveness as well . . . saved $3,528 in 20 months.



2. In Pesco's chucking department, lathes would not hold tolerance during the warmup because of oil characteristics. Mobil product eliminated the problem . . . saved Pesco $1,072 in lost production time. And on automatic chuckers, a Mobil hydraulic oil ended recurrent pressure losses . . . saved $1,960 in maintenance costs in 20 months.

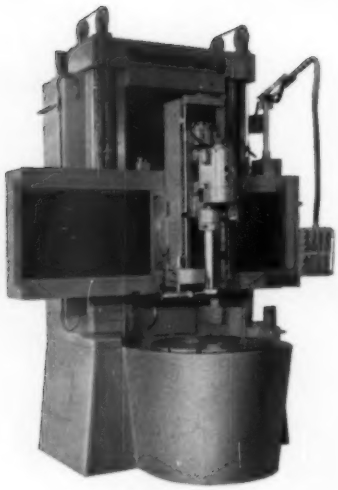


3. On Pesco's hydraulic machinery, oil deterioration led to sticky valves, erratic operation, machine tool shutdowns. Mobil trained plant personnel in preventive maintenance procedures, recommended proper fluids . . . cut hydraulic maintenance by 40%.

4. Mobil studied Pesco's oil usage patterns . . . recommended bulk storage for certain petroleum products. Bulk delivery differential and reduced handling costs totaled $880 for Pesco Products Division in the first year alone.

Lubrication

Vertical Universal Grinders



model 3-TR
52″ swing

Springfield vertical universal grinders are among the most versatile tools you can use for *both* production and toolroom work. Head is easily positioned to grind ODs, IDs, surfaces, offsets and undercuts in *any* combination, generally with one chucking. Work may be regular or irregular in shape, up to 48″ high with up to 52″ swing on standard machines. Weight of workpiece is no problem because gravity works for you in vertical grinding – helps achieve extreme micro-inch finish and concentricity.

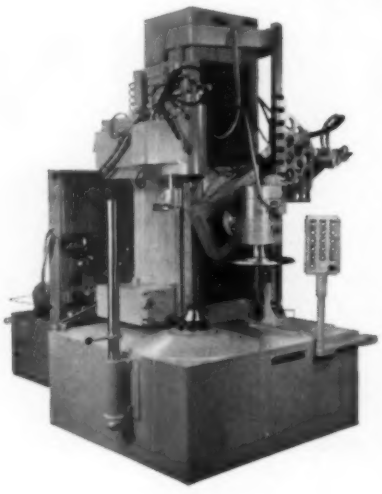
A typical example of a Springfield's remarkable precision is its ability to grind taper valve plugs and seats with one angle setting of the head–and get 95% blue or better on a taper gage with surface finish smoother than 30 RMS.

For high production, sometimes involving automatic loading, cycling, size control and unloading, Springfield builds special vertical grinding machines. Most of these can be reset when part changes occur. Another area in which Springfield has pioneered is in vertical contour grinding machines that handle missile parts.

If you would like to know more about Springfield vertical grinders, please write for Bulletin 197-G.

MMT=PE

new developments coming!



vertical contour grinder

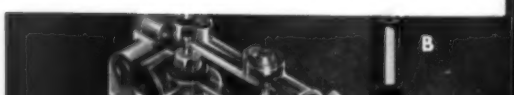
SPRINGFIELD

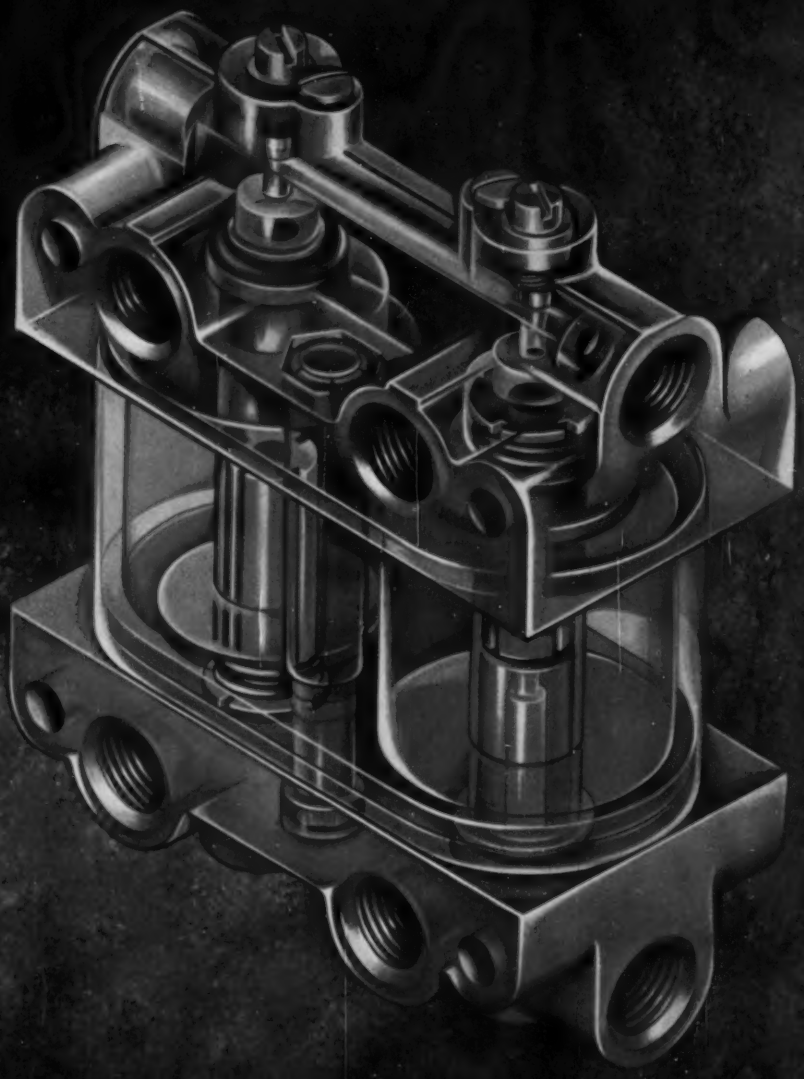
The Springfield Machine Tool Company
Springfield, Ohio

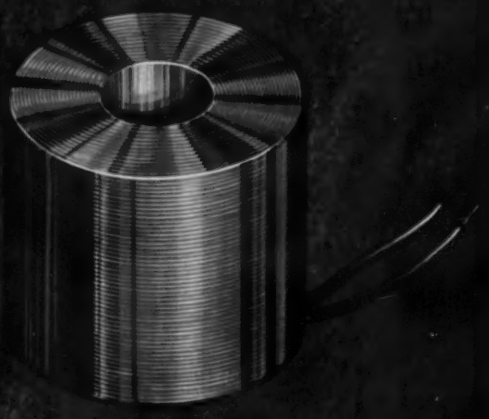
56 CIRCLE 205 READER SERVICE CARD

CIRCLE 206 READER SERVICE CARD ►

Here's how accurate, dependable







Compact 4-way

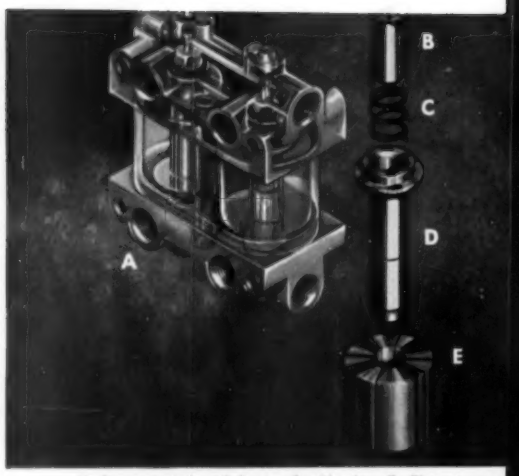
SKINNER

Solenoid Valves

assure precise cylinder control

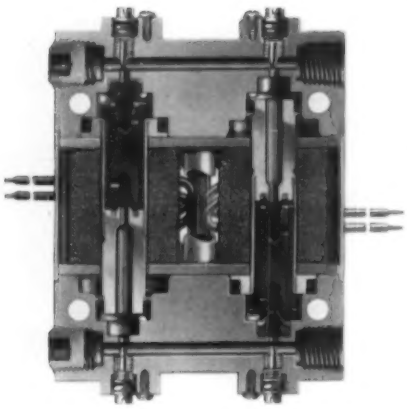
Here's how accurate, dependable operation is built into SKINNER 4-way solenoid valves

- **Precise flow control**—by adjustable metering
- **Compact, direct acting**—two 3-way valves in one housing
- **Durable and corrosion resistant**—stainless steel internal parts
- **Leakproof, bubbletight sealing**—soft, synthetic inserts
- **Positive operation mounted in any position**—spring-loaded plungers
- **Underwriters approved**—wide selection of coils, voltages and frequencies
- **Wired from front or rear**—housing easily reversed
- **Adaptable to many uses**—optional porting arrangements



A. Transparent view of 4-way solenoid valve B. Plunger C. Plunger return spring D. Sleeve E. Coil

SKINNER four-way solenoid valves available in three basic types



The Skinner V9 solenoid valve is two 3-way valves in one compact housing. Both valves may be independently controlled and metered to provide accurate, dependable control of single- or double-acting cylinders, or larger pilot-operated valves.

V9 types are available without adjustable flow and with metering at both exhaust ports, both inlet ports or full metering of all ports.

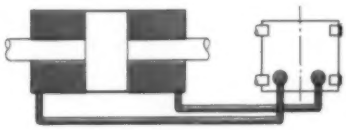
▪ ▪ ▪

For complete information, contact a Skinner Distributor listed in the Yellow Pages or write us at the address below.

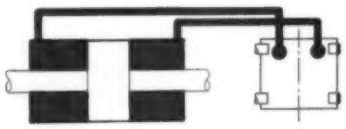
V9 SERIES SPECIFICATIONS

Media—air, hydraulic oils, inert gases
Orifice Diameter—$\frac{3}{64}$", $\frac{1}{16}$", $\frac{3}{32}$", $\frac{1}{8}$"
Pipe Size—$\frac{1}{4}$" NPTF
Maximum Operating Pressure Differential—0 to 150 PSI (up to 225 PSI also available)
Temperature Range—minus 40°F. to plus 180°F.
C_v Factor—$\frac{3}{64}$" .052, $\frac{1}{16}$" .095, $\frac{3}{32}$" .156, $\frac{1}{8}$" .214
Mounting—$\frac{1}{4}$" through-bolt holes.

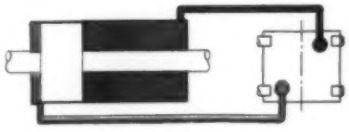
Normally closed—normally closed V933 valves with a neutral position. Generally applied on double-acting cylinders where the piston is in a neutral position without pressure when both coils are de-energized. This permits manual shifting of the piston without operating the valve.



Normally open—normally open V955 valves with a neutral position. Generally applied on double-acting cylinders where both sides of the piston are to be open to pressure when both coils are de-energized. Under certain conditions, the first operating stroke of double-acting cylinders will be smoother with this valve in use.



Normally closed—normally open V935 valves with no neutral position. Generally applied on double-acting cylinders where the piston is to be in retracted or extended position with pressure when both coils are de-energized. Wiring is simple—both coils are operated simultaneously and can be controlled by one single-pole, single-throw switch.



When you specify solenoid valves, specify Skinner. Skinner solenoid valves are distributed nationally.

SKINNER ELECTRIC VALVES®
THE CREST OF QUALITY

SKINNER ELECTRIC VALVES

SKINNER ELECTRIC VALVE DIVISION,
THE SKINNER CHUCK COMPANY • NEW BRITAIN, CONNECTICUT, U.S.A.

PRINTED IN U.S.A.

$5000 Drill Jigs Eliminated!

HARDINGE
ELMIRA, N.Y.

Model UM Universal Milling Machine

RESEARCH WORK *Demands* THE BEST IN MACHINE TOOLS

HARDINGE is the only manufacturer of companion precision machines for milling, straight turning, taper turning, boring, threading and facing with the feature of interchangeable collets, nose fixtures and attachments.

The Hardinge machines illustrated produce precision parts for working models. There are also three Hardinge precision production machines for high speed volume manufacturing—ask for details.

Model DV59 Precision Lathe

Model HLV High Speed Tool Room Lathe

SPECIFICATIONS: *The UM Universal Milling Machine has cutter spindle and spiral dividing head collet capacity of 1-1/16" and a 25 x 6-1/2" swivel table. The DV59 Precision Lathe has 1-1/16" capacity and 9" swing with 17" between centers distance. The HLV Tool Room Lathe has 1-1/16" capacity and 11" swing with 18" between centers distance.*

HARDINGE BROTHERS, INC., ELMIRA, N. Y.

"PERFORMANCE HAS ESTABLISHED LEADERSHIP FOR HARDINGE"

OFFICES IN PRINCIPAL CITIES. Export Office—269 Lafayette St., New York, N. Y.

◀ CIRCLE 207 READER SERVICE CARD

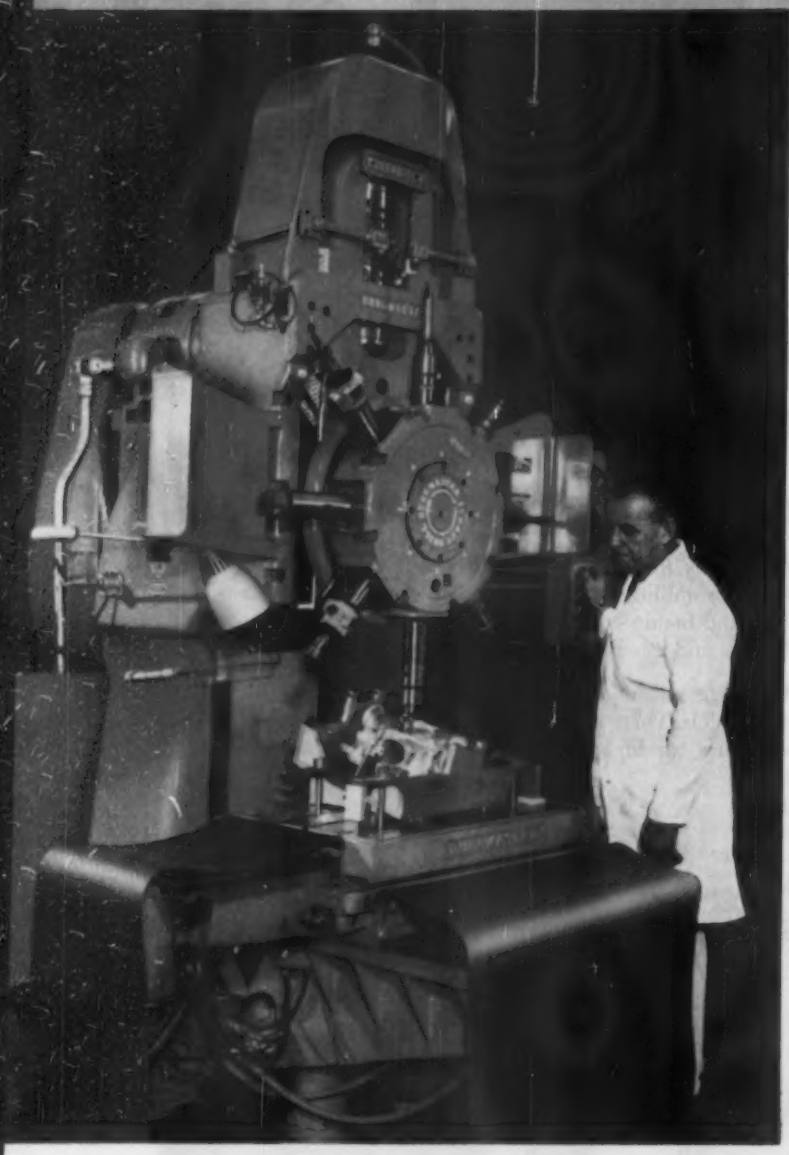
CIRCLE 208 READER SERVICE CARD

Production Increased 56%

World's Largest Builder of Turret

$5000 Drill Jigs Eliminated

BURGMASTER 3BHT tape controlled



- **Reduced lead time**
- **less tool costs**
- **increased production**
- **the virtual elimination of rejects**

— these savings are all made at the Marquardt Corporation in the production of small lots on their Burgmaster Tape Controlled Turret Drilling, Boring and Tapping Machine.

A typical example is in the production of magnesium Manifold housings, usually run in lots of 10. 32 different tools are used to perform 172 operations on 56 holes; three setups are required. Formerly, on a Radial Drill it took 28 hours per part and rejects were high due to the complexity of the job when using jigs. Now on the Burgmaster, the same parts are machined at a rate of 18 hours each, a production increase of 56%, and rejects are nil. $5000 worth of drill jigs and fixtures have been eliminated since they are unnecessary. The Burgmaster positioning table automatically and accurately positions each hole under the machine turret.

Engineering changes, often costly and time-consuming, can be put into production immediately by means of simple tape changes.

IMPORTANT MACHINE FEATURES

1. Preselective individual spindle speeds.
2. Speed range: 20 speeds from 20 to 1700 RPM with 2 speed 10 HP Motors — in 4 speed ranges, or 32 speeds from 70 to 2400 with 4 speed 15 HP Motors in 4 speed ranges.
3. Preselective-Infinitely variable feeds.
4. Hydraulic feeds are automatically temperature compensated.
5. Positive hydraulic feed rates are Dial Calibrated.
6. Table automatically positions on 2 axes and turret indexes simultaneously.
7. Selective rapid approach and return — and preset Depth Stops (quick setting type).

THE MACHINE TOOL

MMT-PE

Booth 840

Exposition - 1960

Production Increased 56%

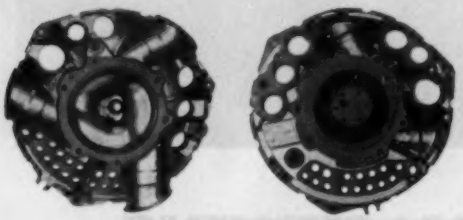
8 SPINDLE TURRET DRILL

(At Marquardt Corp., Van Nuys, Calif.)

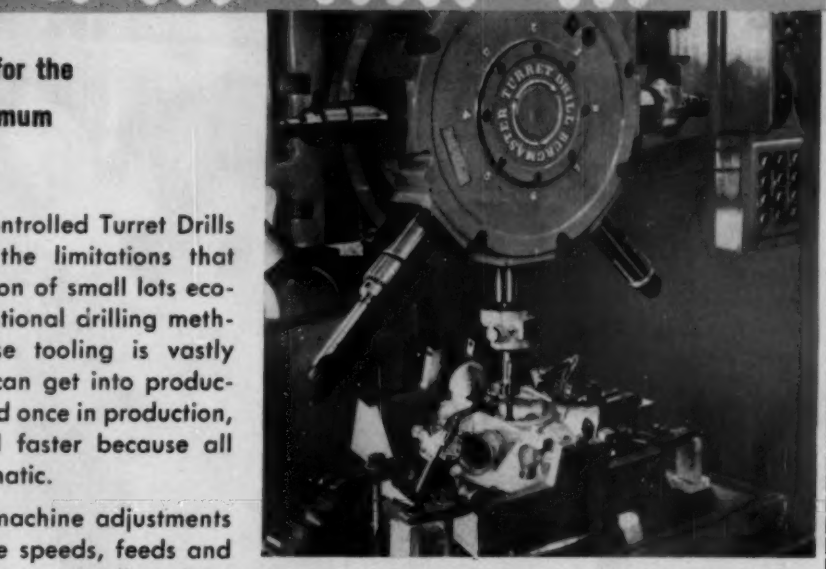
The Ideal Machine for the Small Shop — Maximum Flexible Automation

Burgmaster Tape Controlled Turret Drills overcome most of the limitations that prevent the production of small lots economically by conventional drilling methods. This is because tooling is vastly simplified and you can get into production within hours. And once in production, the job is produced faster because all operations are automatic.

After the standard machine adjustments are made for spindle speeds, feeds and depth of cut, the tape controls all machine functions. This action eliminates jigs, indexing fixtures, or other costly locating devices. Layout is not required, nor is the usual operator "breaking-in" period.



Magnesium Manifold Housing requires 32 different tools — 172 operations on 56 holes. Operations include centerdrill, drill, spotface, core drill, bore (adjustable boring head), c'sink, ream, AND port cutters, tap and mill.



Closeup shows tilting fixture used to machine an angular hole in the manifold housing. Three fixtures and setups are used: one for each side, and one for the angular hole.

JOB FACTS

Company:	The Marquardt Corporation, Van Nuys, California
Machine:	Burgmaster 8-Spindle Tape Controlled Turret Drilling, Boring and Tapping Machine.
Part:	Manifold Housing.
Material:	Magnesium.
Quantity:	10 parts.
Holding:	3 locating fixtures: 1 for each side; 1 for angular hole.
Accuracy:	Bore ±.001, ream ±.0005, centers ±.001.
Former Time:	28 hours per part on a Radial Drill using drill jigs and fixtures.
Present Time:	18 hours per part.
Production Increase:	56%, and no rework.
Advantages:	Increased production 56% while eliminating rejects—eliminates $5000 fixtures — economically handles small lot work — reduces lead time — speeds engineering changes.

Write for Bulletin describing Burgmaster 6 and 8 Spindle Tape Controlled Turret Drilling, Tapping and Boring Machines. Forty-minute 16mm sound film showing all Burgmaster Turret Drills in operation is available without charge.

World's Largest Builder of Turret Drilling Machines

"O" Manual Power Index ¼" Capacity

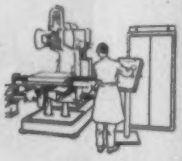
1C Manual Power Index ⅜" Capacity

2B Manual Power Index ¾" Capacity

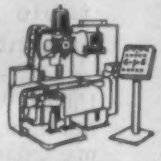
2BR Ram Type Radial Drill ¾" Capacity

2BH Automatic Hydraulic ¾" Capacity

3BH Automatic Hydraulic 1½" Capacity



25AH Automatic Tape Controlled 1¼" Capacity



2BHT-3BHT Automatic Tape Controlled ¾" and 1½" Capacity

BURG TOOL

MANUFACTURING COMPANY, INC.

15001 South Figueroa St., Gardena, Calif.

FAculty 1-3510 • DAvis 9-4158

BURGMASTER DIRECT SALES OFFICES: Ridgewood, N.J., 86 North Maple Ave., Gilbert 4-3002 • **Chicago 5, Ill.,** 4908 Lincoln Ave., LOng Beach 1-1178 • **Cleveland 7, Ohio,** 14706 Detroit Ave., ACademy 6-7030 • **Detroit 37, Mich.,** 13730 W. Eight Mile Rd., LIncoln 8-4333 • **San Francisco, Calif.**

Plus dealer representatives in other industrial centers.

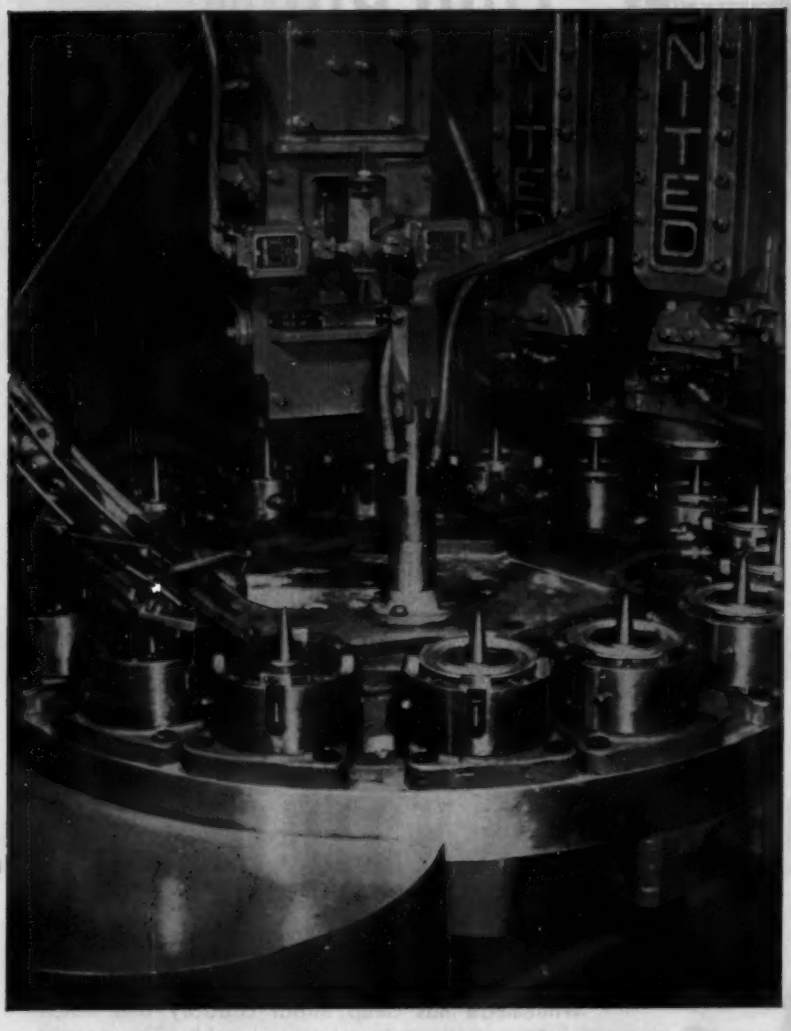
DOW | NOW IN MAGNESIUM AND ALUMINUM

10¢ PHONE CALL CUT MACHINING TIME 50% ON 3-FT. INDEX TABLE!

Ordered-by-phone magnesium tooling plate disc replaced cast steel index table for machinery manufacturer . . . "as purchased" flatness cut previous machining time on this part in half . . . saved 50% on machining costs.

United Welders Inc., of Bay City, Michigan, recently replaced steel with magnesium tooling plate in making the precision index table, or dial, for their automatic 8 Station Dual Dial Welder. This machine is used in welding the bottom gasket retainer for an oil filter assembly in 1960 automobiles.

The dials previously were made of cast steel which required costly, time-consuming surface and edge machining to finish. The 2½ inch by 36 inch dials of magnesium tooling plate are now purchased rough-cut to size from the local Dow magnesium distributor, and are finished by simply edge truing and drilling. Because the as-purchased flatness completely eliminates need for surface machining, United's machining costs on this part have been cut by more than half. Production has been speeded, too, because magnesium's light weight makes the dials easy to handle during manufacture. Two men can easily lift and handle the light disc. Cranes or lift trucks aren't needed as they were with the previous steel dials.



Because magnesium tooling plate is uniformly flat, it can be used for almost all tooling jobs without surface machining. It's rolled and thermal flattened to close flatness tolerances . . . high dimensional stability keeps it flat in use.

MAGNESIUM TOOLING PLATE IS AVAILABLE FROM STOCK AT:

Clendenin Bros., Inc.
Baltimore, Maryland

Copper and Brass Sales, Inc.
Cleveland, Ohio; Detroit 12, Michigan

Fullerton Steel and Wire Company
Chicago 35, Illinois

Hubbell Metals Inc.
St. Louis 3, Mo.; Kansas City, Mo.; Marietta, Ga.

A. R. Purdy Co., Inc.
Lyndhurst, New Jersey

Reliance Magnesium Company
Los Angeles 58, California

Joseph T. Ryerson & Son, Inc.
Dallas, Texas

LIGHTNESS CUTS POWER NEEDS 75%

In the United welder above, the dial starts and stops 500 times per hour during welding operations. This lightweight magnesium dial requires only a quarter of the power needed to operate the previous steel dial. It permits a drastic reduction in the cost and size of motor, speed reducer and other necessary driving elements.

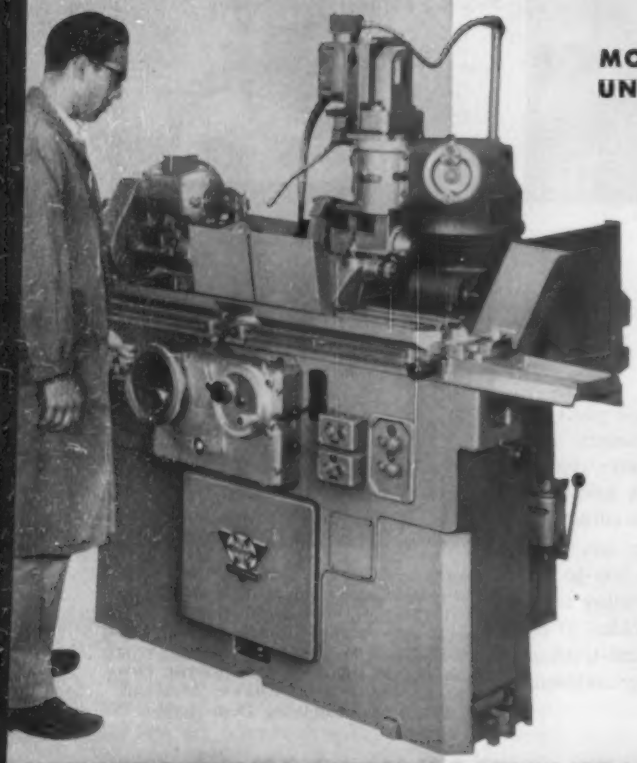
RIGIDITY MEANS ACCURATE POSITIONING

United Welders employs a Geneva Stop Movement to position parts accurately under dual automatic spot welding heads. Magnesium's rigidity helps the dial retain close tolerances necessary for continued accuracy.

Magnesium tooling plate has other advantages, too. It costs less to buy than other lightweight tooling materials and can easily be welded. It can often be obtained ready-cut-to-shape from distributors, saving additional time in your shop.

There's a wealth of information in Dow's new magnesium tooling plate manual. This handy 56-page book is filled with facts about shop working characteristics, machining, etc. For a copy, contact your Dow branch office or write to THE DOW METAL PRODUCTS COMPANY, Midland, Michigan, Merchandising Dept. 1033F6-13.

THE DOW METAL PRODUCTS COMPANY, Midland, Michigan
DIVISION OF THE DOW CHEMICAL COMPANY



MICRO MATIC
HONE CORPORATION DETROIT MICHIGAN
MANUFACTURED BY JONES-SHIPMAN LEICESTER, ENGLAND

TOOLROOM GRINDERS

MANY UNUSUAL FEATURES ASSURE HIGH EFFICIENCY

MODEL 310
CUTTER AND TOOL GRINDER

This grinder efficiently performs a wide range of grinding operations. Thus, tools and cutters can be ground in shortest possible time to keep production costs at a minimum.

FEATURES:

Universal operating positions—all within comfortable reach of operator • Anti-friction cross saddle mounting assures sensitive control to cross feed • Table traverses on precision roller chains, giving "fingertip" control • Table dogs reversible—one end spring loaded and the other a dead stop • Table swivels a full 90 degrees in left-hand direction and 45 degrees right-hand • Large diameter wheel spindle, mounted on specially selected preloaded bearings • Universal Cutter Head adjustable to swing from 8" to 12" diameters • Cutter Head and Tailstock provided with clearance angle setting adjustments.

For additional information, write for Micromatic Bulletin 139W.

MODEL 1014
UNIVERSAL TOOLROOM GRINDER

This 1014 Universal Tool Room Grinder is designed to give extraordinary sensitive control that results in *high quality external and internal grinding.*

Wheelhead has deep throat capacity and wheel position is centralized in relation to table. This permits surface grinding and offers special facilities for broach grinding.

The extra Universal Cutterhead extends the versatility of this highly accurate machine to cover tool and cutter grinding.

FEATURES:

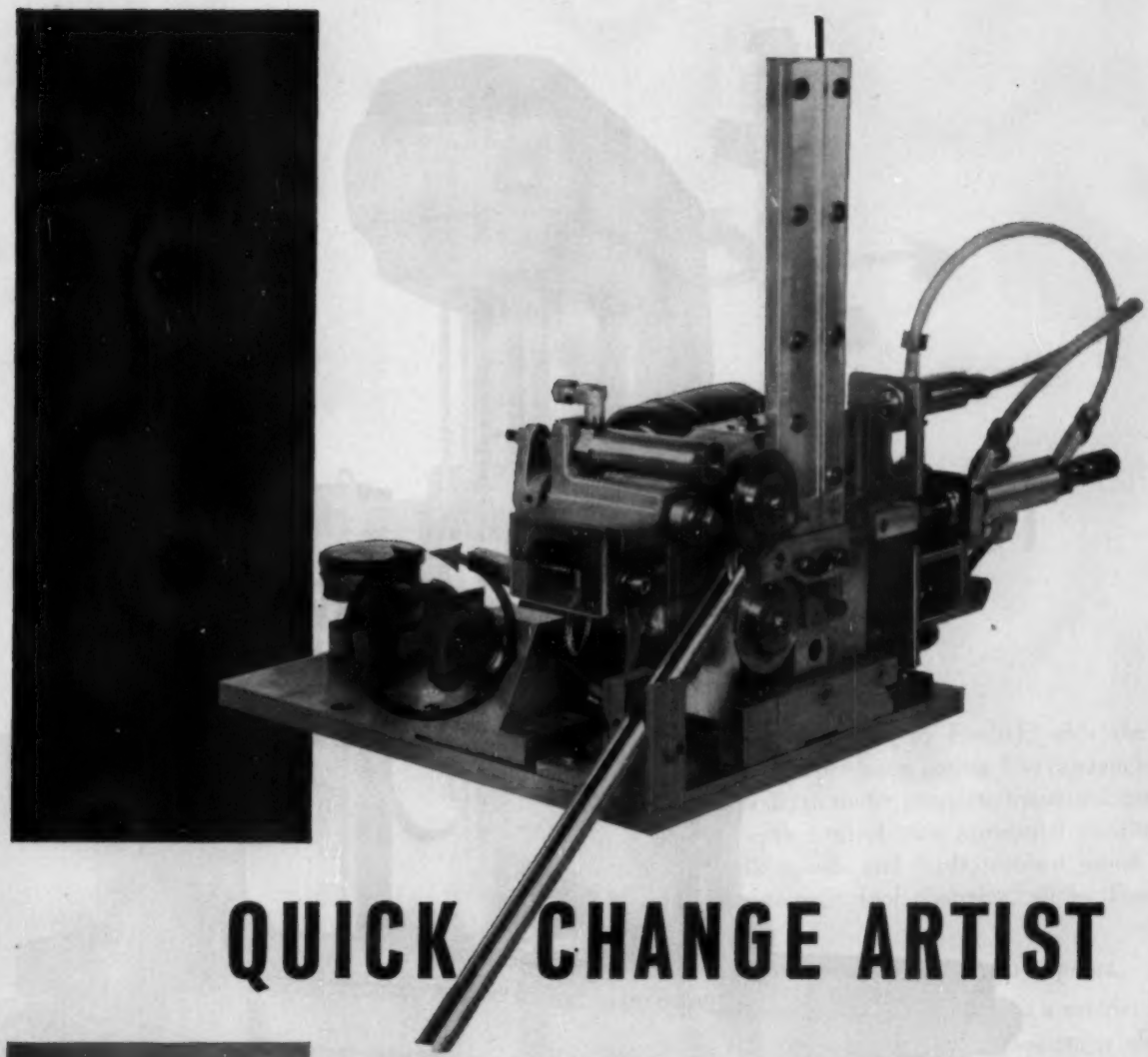
Hand cross feed and vertical feed in .0001" increments • Auto cross feed per reversal of table of .0001" to .007" over .025" (reduction in work diameter of .050") • Automatic table traverse, 4 speeds provided. Micrometer adjustment to table traverse in .001" divisions • Wheelhead saddle on anti-friction mountings • Precision built wheelhead motor on anti-vibration mountings • Wheel spindle unit swivels full 360° • Five external grinding wheel speeds • Grinding wheels fitted on either end of wheel spindle. Nitralloy spindle runs in plain bearings • Vernier scales to wheelhead and table swivels • Fast cross traverse to wheelhead for setting purposes.

For additional information, send for Micromatic Bulletin 206Q.

MICROMATIC HONE CORP.

8100 SCHOOLCRAFT AVENUE • DETROIT 38, MICHIGAN

PRECISION PRODUCTION THROUGH MICROMATIC



QUICK CHANGE ARTIST

Here's "packaged tooling" for internal grinding that's really versatile. With the turn of a single knob, fixtures can be interchanged to permit rapid set-up away from the machine. Production continues with hardly an interruption.

Quick change "packaged tooling" is only one of the many exclusive features of the Bryant Model "B" Centalign® — features which are helping manufacturers of miniature components establish new records for accuracy and production.

If you are grinding the bores or raceways in miniature bearings or similar parts, investigate the Bryant Model "B" Miniature Centalign. It will repay you in increased profits.

P.S. Space is no problem with the Bryant Miniature Centalign. It packs all its job-engineered features in only 8¼ square feet.

BRYANT Chucking Grinder Co.

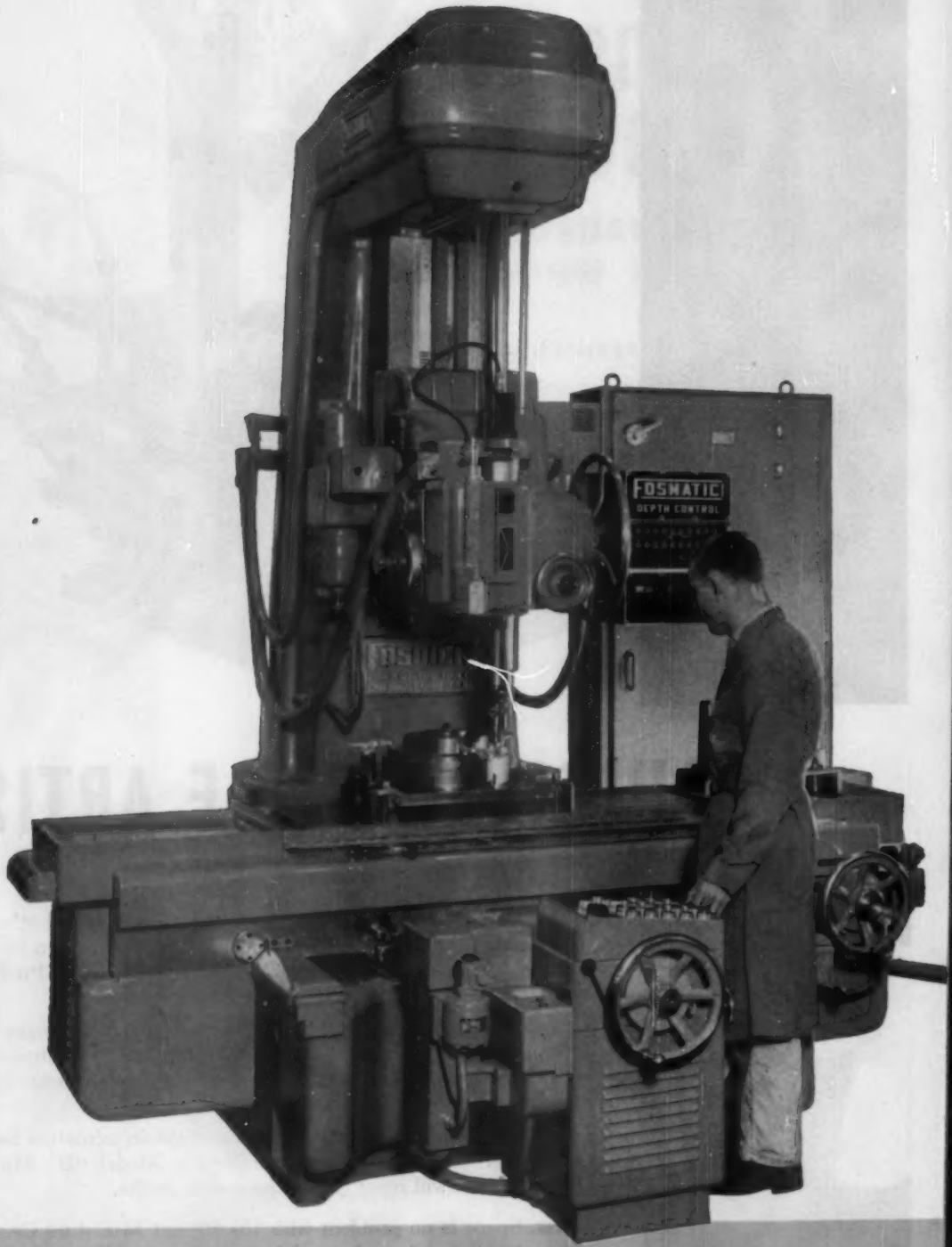
85 CLINTON STREET, SPRINGFIELD, VERMONT

Offices: Springfield, N. J. • Cleveland • Detroit • Indianapolis • Chicago • Los Angeles

Internal Grinders • Special Machinery

◀ CIRCLE 213 READER SERVICE CARD

CIRCLE 214 READER SERVICE CARD



PRECISION

Numerical Control
in three directions

DEPTH CONTROL developed by Fosdick, adds the ultimate *third dimension* to precision boring. Use random length tools for boring to depth under complete numerical control. Combine rapid depth control with horizontal positioning, preselected spindle speeds and feeds, coolant on-off, tool selection, even automatic tool changing, all by Fosmatic Numerical Control.

Tape or dial any depth. Absolutely no stops to preset.

Fosmatic Numerical Control easily fits into a cabinet small as your home refrigerator. The Fosdick system is electromechanical. Its electrical components are simple, easily maintained.

Always, with or without numerical control, you depend on a Fosmatic for precision within 0.0001".

Keep precision machining control in the front office. Relieve the operator of his "fear of error." Investigate—and invest—in lower costs with Fosmatic precision, now. Write for Catalog PB-A.

BORING **FOSDICK**

THE FOSDICK MACHINE TOOL COMPANY
CINCINNATI 23, OHIO

MORSE...CINCINNATI BICKFORD GIVE

So it doesn't break---*So what??*

So we can bend a MARVEL High-Speed-Edge Hack Saw Blade double, and it won't break. Does this prove anything?

Let's see if it does. When you buy a box of hack saw blades, you expect each blade to have a reasonable cutting life. For example, take an ordinary blade that costs $4.00, and you expect it to produce 2000 sq. inches of accurate cutting-off before it is discarded. Would you be willing to pay $8.00 for that same blade? *You will, if it breaks halfway through its expected life.*

Bending a MARVEL High-Speed-Edge Hack Saw Blade to demonstrate that it is truly unbreakable proves the point that you get every square inch of blade life you pay for when you buy MARVEL Blades.

Safety to both operator and machine, plus maximum blade life, seem like value enough from this remarkable blade. However, these MARVEL Blades give you even more, for they will cut faster, with greater accuracy because they can be safely tensioned more taut in your machine than ordinary "breakable" blades and are therefore more rigid to resist deflection.

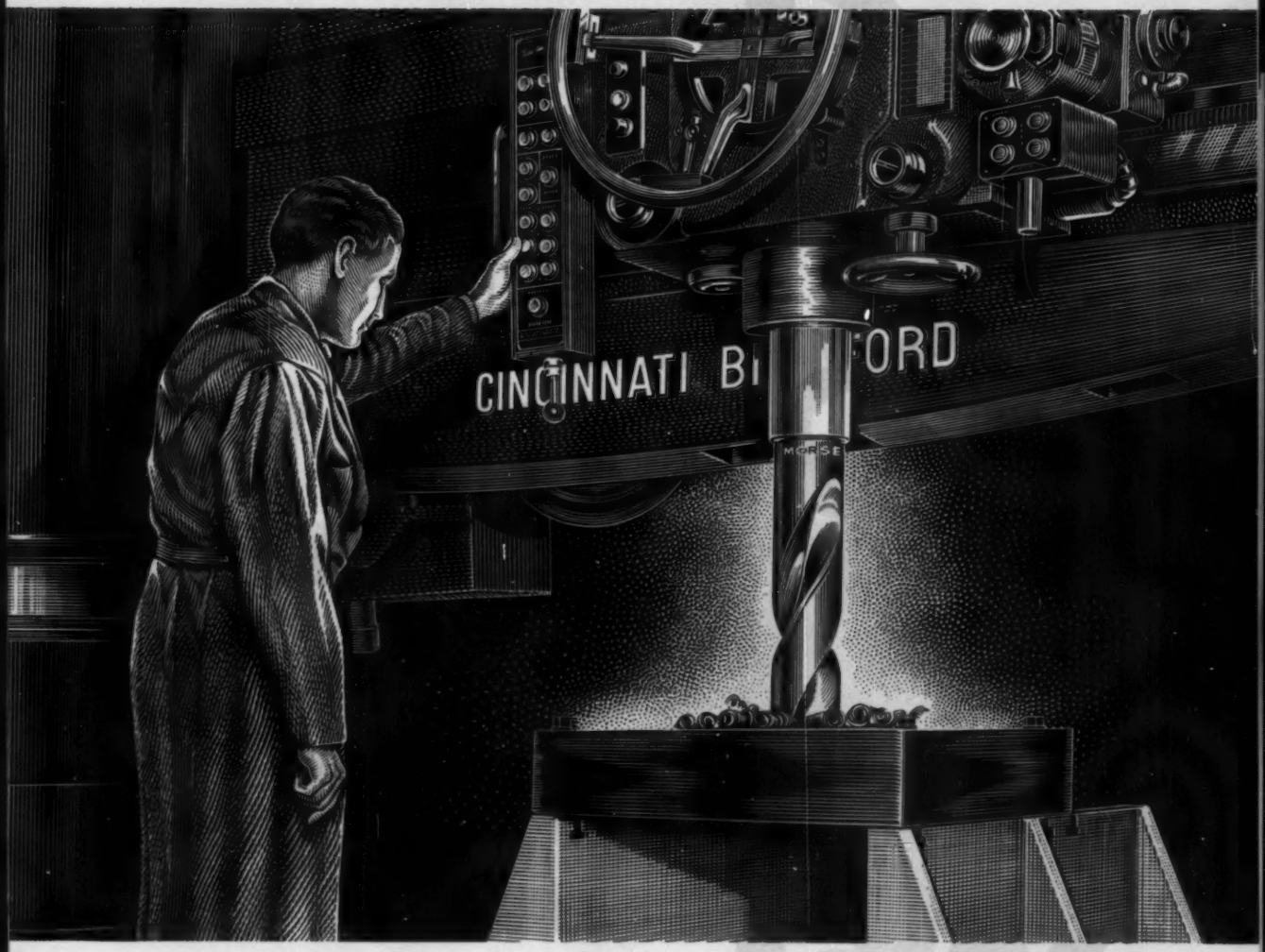
Cost? Unbreakable MARVEL High-Speed-Edge Hack Saw Blades are priced competitively. Use MARVEL Blades consistently with complete confidence because they have no equal for value. Leading Industrial Distributors stock and sell MARVEL. Ask yours today.

MMT·PE

ARMSTRONG-BLUM MANUFACTURING CO.
5700 West Bloomingdale Avenue • Chicago 39, Illinois

Metal Cutting MARVEL SAWS
Better Machines - Better Blades

MORSE...CINCINNATI BICKFORD GIVE A SHOW OF STRENGTH



Morse tough tools easily take the thrust of world's most powerful radial drill... utilizes its full power.

Cincinnati Bickford caused many a drill manufacturer to throw up his hands when they looked for a drill tough enough to stand up under the thrust of the most powerful radial drill ever built. They found what they wanted at Morse... a regular taper shank drill right off the shelf.

Let Morse provide the easy solution for your tough jobs. Your Morse-Franchised Distributor will give you full details. Call him today.

Morse means more production... smoother, more accurate production . . . with every type of cutting tool from drills, reamers, taps and dies, to end mills, milling cutters, slitting saws and "specials". So, if you want the best from every cutting tool you buy, mark your order "MORSE". For if you want *Morse Quality*, there's only one way to get it... *specify Morse.*

MORSE

means "THE MOST" *in Cutting Tools*

MORSE TWIST DRILL & MACHINE CO., NEW BEDFORD, MASSACHUSETTS

Warehouses in: NEW YORK • CHICAGO • DETROIT • DALLAS • SAN FRANCISCO

A Division of VAN NORMAN INDUSTRIES, INC.

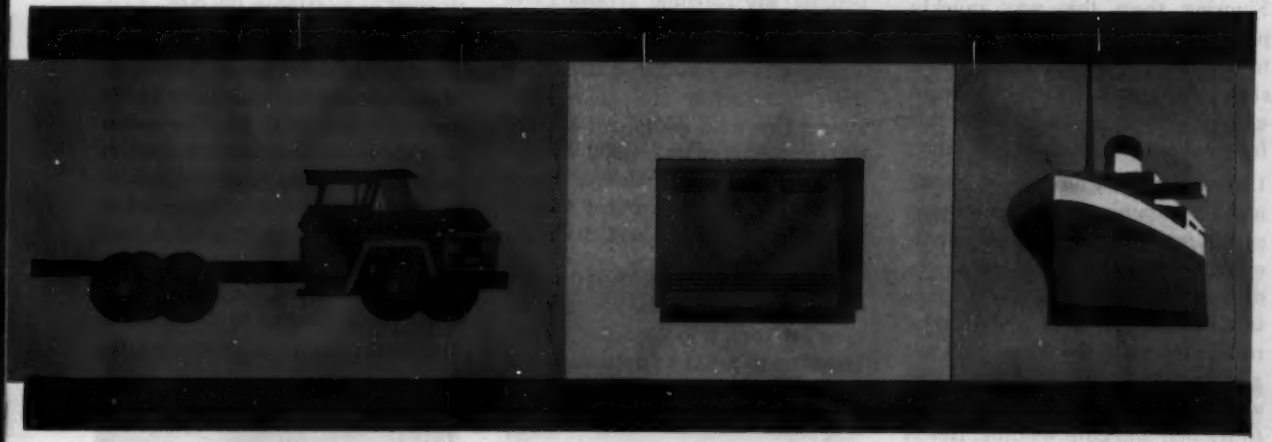
CIRCLE 218 READER SERVICE CARD

2378

DESIGN FOR
LESS WEIGHT AND
LONGER LIFE IN YOUR
PRODUCT WITH

N-A-X HIGH-TENSILE

STEEL



You can design light weight, longer life, and economy into your products by including N-A-X HIGH-TENSILE in your plans and specifications. This versatile, corrosion-resisting, low-alloy, high-strength steel has many attractive features of special value to designers and manufacturers. For example:

- It is 50% stronger than mild carbon steel.
- It offers superior resistance to atmospheric corrosion.
- It has high fatigue life and great toughness.
- It has greater resistance to abrasion or wear.
- It has great paint adhesion, with less underfilm corrosion.
- It is readily welded by any process.
- It is stable against aging.
- It polishes to a high luster at minimum cost.
- It can be cold formed readily into difficult stampings.

With its many diversified applications in modern metal design, it will pay you to investigate N-A-X HIGH-TENSILE for savings in weight, in production time and for longer product life. A thoroughly competent metallurgical service organization is available to work with you on any application problem you may have. Write, wire or phone Product Development Department, Great Lakes Steel Corporation, Detroit 29, Michigan.

N·A·X HIGH-TENSILE STEEL

A PRODUCT OF

GREAT LAKES STEEL

Detroit 29, Michigan

Great Lakes Steel is a Division of **NATIONAL STEEL CORPORATION**

REDUCE

. . . with Barber-Colman

You can't measure hob or cutter costs by purchase price alone. To find true cost, add time and labor on sharpening machines, plus losses incurred by improper sharpening.

Figuring them this way quickly proves that your best opportunity to save money is by doing a better sharpening job. Barber-Colman *automatic* sharpeners will do this for you, and reduce costs *four* ways:

1. *Tool depreciation cost*—Accurate index sharpening distributes wear evenly over all cutting teeth, avoids excessive stock removal to recondition tools. It permits you to maintain original accuracy and thereby reduce rejects. Fine finish, with wet grinding and our new automatic wheel dressers, reduces tool wear due to friction and chip welding. Result —you get a greater number of acceptable pieces for every dollar you spend on tools.

2. *Sharpening cost*—Have you given much thought to hidden costs like this? Sharpening is a major addition to tool cost, and one of the first places to look when your costs seem high.

Barber-Colman's new sharpeners feature automatic wheel dressing. They give you positive control over cost and quality. You never have to stop sharpening to dress a wheel because the machine *dresses as it sharpens.*

Variable table speed and stroke reduce both setup and sharpening times. One man easily can operate several machines and produce high-quality work. High cost of finger sharpening can be avoided with a method that is fast and accurate.

3. *Inspection cost*—Automatic sharpening reduces the need for inspecting each hob or cutter. Spot-checking to avoid setup mistakes is all you need to maintain quality.

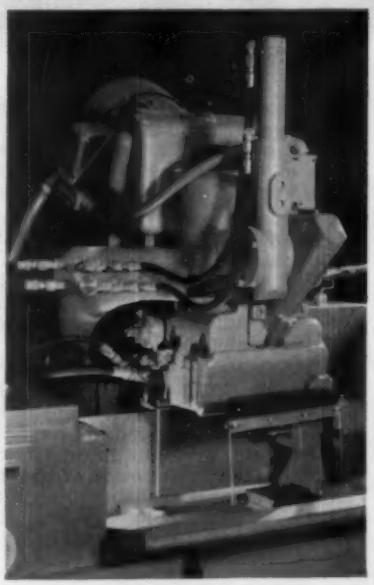
4. *Tool change cost*—Another major cost is downtime on your hobbing or milling machines to change tools. This can be minimized if improved sharpening will increase the number of pieces produced between grinds.

This sums up the approach by which you can make expensive cutting tools worth more to you today in terms of total cost per piece.

Automatic dressing key to improved sharpening

Almost everything you do on a hob or cutter sharpener can be improved by Barber-Colman's new automatic dresser — available on Nos. 4 - 8, 6 - 5, and 10 - 12 machines.

Your sharpening speed, accuracy, finish, wheel wear, and diamond life are controlled positively. The human element is removed from the fine art of dressing. Even spark-out is controlled automatically. This assures consistent accuracy, fine finish, and more work per man-hour. One operator easily can keep several machines busy because he is freed from the responsibility of attending the



TOOL COSTS

Automatic Sharpeners

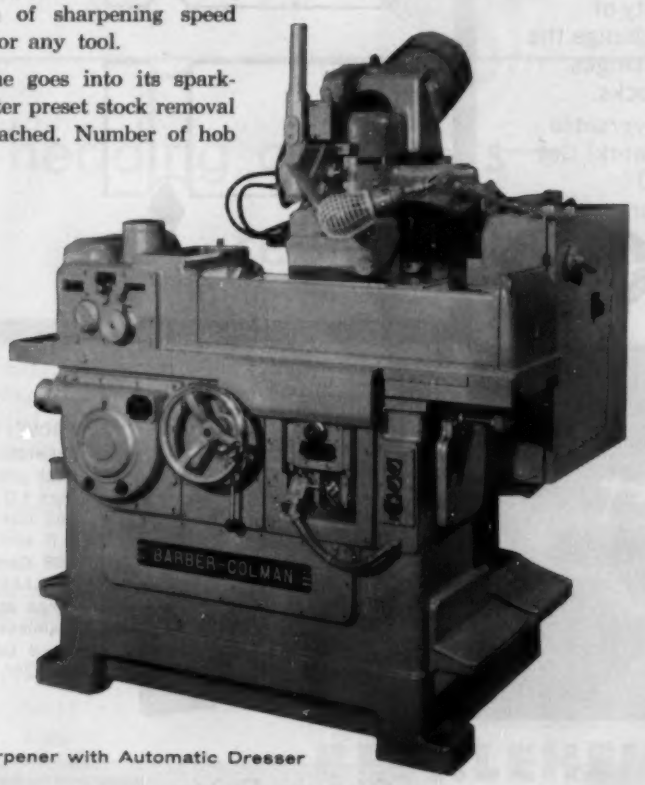
wheel. Loading and heat-checking are controlled for him. Here's how automatic dressing works:

The hydraulically actuated dresser arm operates continuously as the machine sharpens. The operator never stops the cut to dress a wheel. The wheel feeds into the diamond a predetermined amount before each dressing cycle. Amount of infeed and speed of the dresser arm control finish. Both are infinitely variable. This permits you to obtain the best combination of sharpening speed and finish for any tool.

The machine goes into its spark-out cycle after preset stock removal has been reached. Number of hob and cutter revolutions during spark-out also can be preset, thus providing a fully automatic operation.

New No. 4-8 sharpening machine speeds operation

If you are sharpening hobs, thread mills, or form cutters up to 4" diameter by 4" face width on old-style automatic sharpeners or cutter grinders, here is a machine that will cut costs *in half*.



No. 6-5 Sharpener with Automatic Dresser

The new Barber-Colman No. 4-8, with maximum table stroke of 10¾", will sharpen two 4" cutters simultaneously. It offers all of the latest advances in design, such as:

1. Automatic wheel dressing
2. Wet or dry grinding
3. Automatic spark-out
4. Quick-change arbors
5. Infinitely variable table speed and stroke
6. Rigid wheel head mounting

Call your Barber-Colman representative for assistance in setting up a sharpening program that reduces the *real* cost of hobs and form-relieved milling cutters.

Barber-Colman Company

BARBER COLMAN

61 Loomis Street, Rockford, Illinois

See the new No. 6-5 Sharpener with Automatic Dresser in Action at the Machine Tool Exposition Booth No. 923

MMT·PE

CAM BORE PRECISION... AT THREE TIMES THE SPEED OF A BAR AUTOMATIC

STANDARD STYLE 308 BORES AND CONTOURS MINIATURE BEARING RACES FROM BAR STOCK

Take a standard Ex-Cell-O Style 308 Cam Boring Machine, feed bar stock through its Ex-Cell-O Precision Spindles, and add the tooling shown at right.

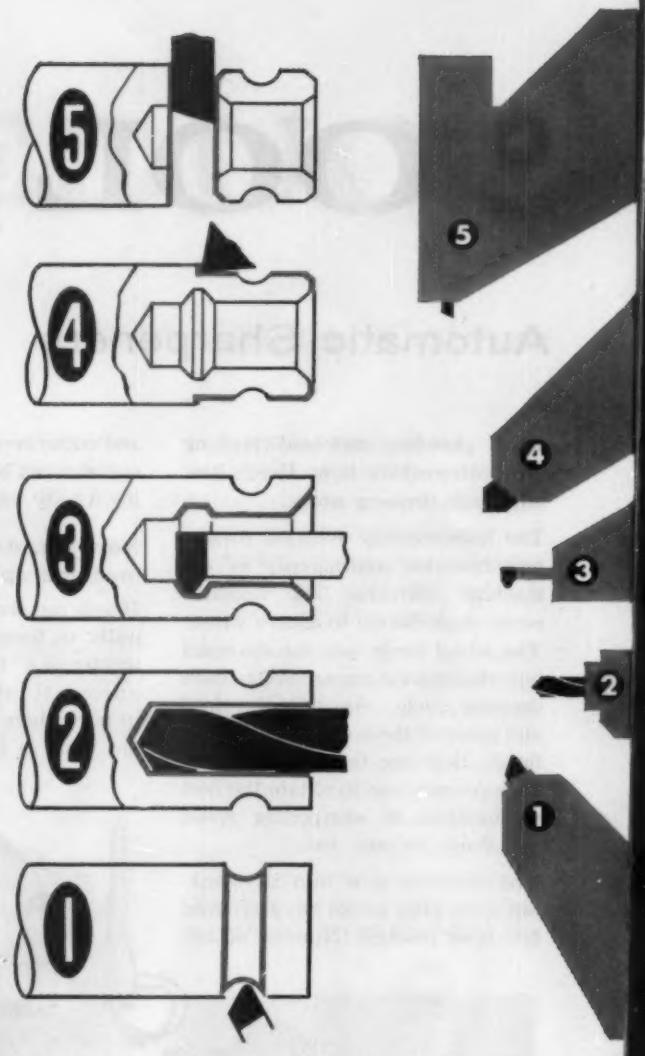
The result: 380 miniature bearing races per hour, gross—produced three times faster, 10 times more accurately, and with more operations and a finer finish than possible with the bar automatic assigned to the same work!

Ex-Cell-O Precision Cam Boring Machines use direct cam action on table and cross slide to perform an endless variety of boring and contouring work. To change the part form, the operator simply changes two convenient cams and tool blocks.

How many ways can you use a versatile boring machine like this in your work? Get the fact-story from your Ex-Cell-O Representative, or write direct for details on the complete line.

MMT-PE

SEE EX-CELL-O'S BOOTH 946, NMTBA EXPOSITION



ABOVE: Operations are (1) generate track, (2) drill, (3) back chamfer and contour bore I.D., (4) face, chamfer and turn O.D., (5) chamfer O.D. and cut-off. LEFT: Style 308 Cam Boring Machine. FAR LEFT: Part (shown 2½ times actual size) is 440C stainless steel. Tolerance is held to plus or minus .00025", finish to 20 RMS.

60-28

EX-CELL-O FOR PRECISION

MANUFACTURERS OF PRECISION MACHINE TOOLS • GRINDING AND BORING SPINDLES • CUTTING TOOLS • DRILL JIG BUSHINGS • TORQUE ACTUATORS • CONTOUR PROJECTORS • GAGES AND GAGING EQUIPMENT • GRANITE SURFACE PLATES • AIRCRAFT AND MISCELLANEOUS PRODUCTION PARTS • ATOMIC ENERGY EQUIPMENT • RAILROAD PINS AND BUSHINGS • DAIRY AND OTHER PACKAGING EQUIPMENT

Machinery Division

EX-CELL-O CORPORATION

DETROIT 32, MICHIGAN

Cold-heading cuts costs— replaces two parts with one!

The two-piece part, comprising a stud and a seat, has been replaced by a single part which is now cold-headed at considerable savings. It's used in the assembly of an automotive steering-rod relay system.

A special type of Bethlehem cold-heading wire was developed for this job. Costs are well under the previous method of manufacture. Cups have good surface finish and high strength.

This is a typical example of the small parts which are constantly under study by manufacturers searching for better materials, improved methods, and lower costs.

Look at these advantages of cold-heading

High-speed production . . . low scrap loss . . . economical stock . . . high strength . . . minimum of finishing operations.

Perhaps your product can be cold-headed

Heading-quality wire, custom-made for the job, has long been a Bethlehem specialty. Our metallurgical engineers will gladly work with you if you have a product that might be cold-headed. For any of your wire needs, call your nearby Bethlehem office, or write us at Bethlehem, Pa.

Steel
For strength
. . . economy
. . . versatility

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.
Export Distributor: Bethlehem Steel Export Corporation

BETHLEHEM STEEL

BETHLEHEM STEEL

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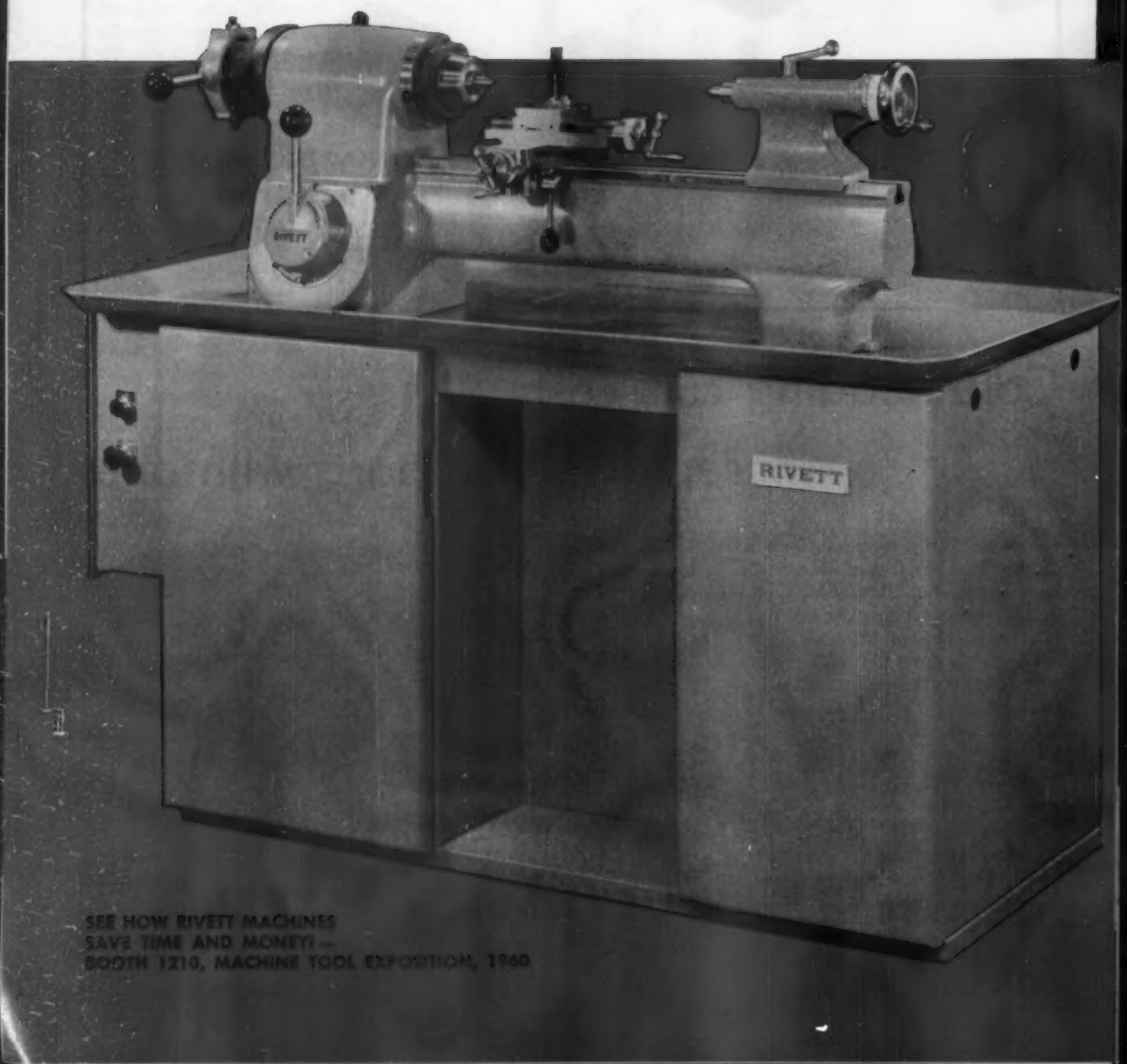
CIRCLE 224 READER SERVICE CARD

RIVETT

helps you prepare for the 60's with its...



SEE HOW RIVETT MACHINES
SAVE TIME AND MONEY! —
BOOTH 1210, MACHINE TOOL EXPOSITION, 1960

ALL NEW

SIXTY

series

precision speed lathe!

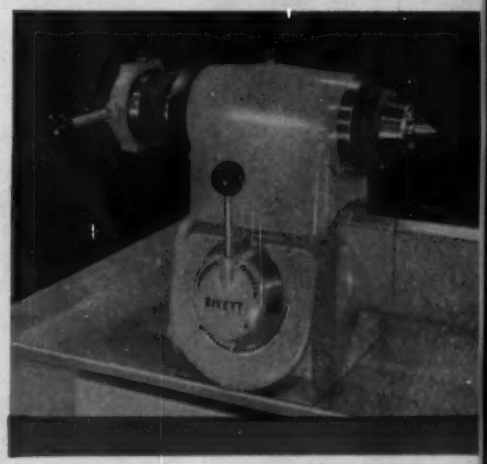
Here is a production tool of speed, accuracy and durability that combines the perfection of the most modern materials and engineering skill with the know-how of three generations of lathe building experience.

RIVETT

Featuring "one motion control"

1 Single lever starts lathe spindle and selects any speed within the range up to 4800 r.p.m. Same lever will change speed during operation or instantly stop or reverse spindle. Stops may be set for repeating selected speeds on duplicate work.

No waiting during speed selection or speed change. There is greater ease of operation, less handling time, and an opportunity for greatly increased production.



And 4 other Rivett "Firsts" for more precision work on a greater variety of jobs!

2 **NEW BED FORM FEATURES DOUBLE-BEVEL AND DOVETAIL.** Double-Bevel positively centers tailstock in alignment with headstock and the large bearing area prevents below-center wear. Dovetail aligns compound slide rest and evenly distributes its bearing on top of bedway as tool pressure pulls against inverted dovetail.

3 **SPINDLE WITH TRUE ROUNDNESS AND RIGIDITY.** Large diameter super-precision ball bearings of highest quality fitted to in-line ground mountings assure near-perfect roundness. Constant bearing preload, unchanged by speed or heat, holds spindle rigid against both side and end pressure of cutting tool. Unusually heavy wall and wide bearing spacing contribute to spindle's rigidity.

Endless vee belts replaced without disassembling spindle. 1-½" collet.

4 **COMPOUND REST WITH HARDENED STEEL SLIDES.** All mating slides are machined from steel, then fully hardened and ground. Feed screws will continue free from backlash; they are ball bearing mounted and have heat treated threads turning in nuts which automatically compensate with wear.

Contrasting black markings on white dials record feed of cross slide "on diameter" and feed of compound slide in direct linear motion.

A clamping handle located in front for maximum convenience aligns and locks slide rest to bed's top surface and dovetail.

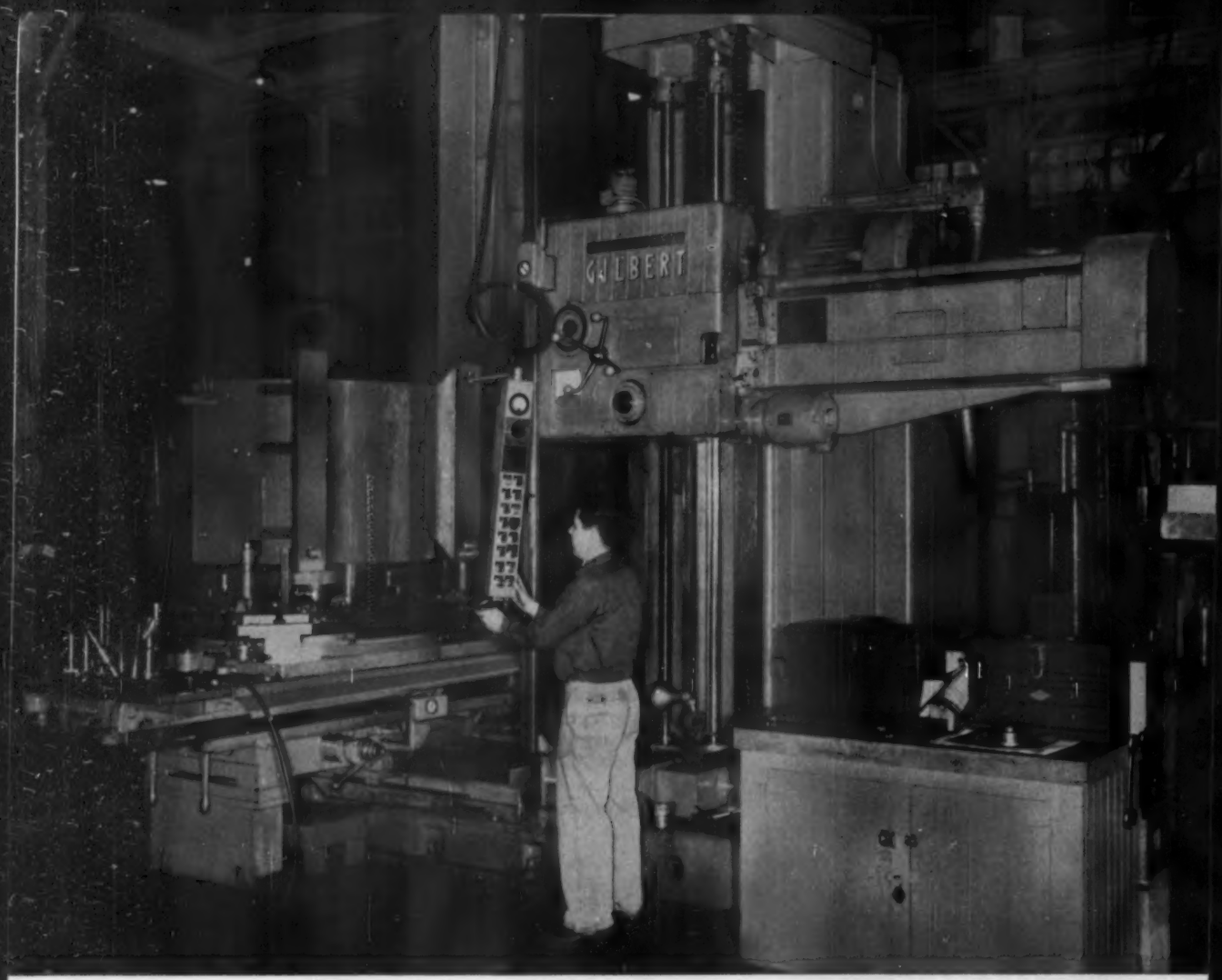
5 **DISTORTION-FREE MOUNTING.** Uneven or non-rigid floor cannot distort lathe. Bed has three-point mounting on a steel channel isolated from any distortion of cabinet.

RIVETT LATHE & GRINDER, Inc.

Brighton 35, Boston, Massachusetts

Dept. AM-6

CIRCLE 226 READER SERVICE CARD



Courtesy The Reliance Electric and Engineering Co.

5″ Gilbert cuts setup time 20%, operating time 20% for Reliance

"This 5" Gilbert is saving us approximately 20% on setup and 20% on operating time on motor frames," reports W. R. Henninge, Methods Engineer at The Reliance Electric and Engineering Co., Cleveland.

But those are only part of the savings earned by this versatile machine. On some close tolerance jobs, such as rockers, Reliance either had to make jigs costing $500 and more, or send each part to their tool room to be run on a jig borer.

Now, by making a very simple locating fixture, and using the Gilbert's automatic positioning, they have cut the job in half. At the same time, they have eliminated scrap and improved accuracy for assembling.

Wouldn't savings like that be important to your company? Your nearby Cincinnati Gilbert representative can show you how to get them.

The Cincinnati Gilbert Machine Tool Co., 3340 Beekman St., Cincinnati 23, Ohio

Ask for new catalog

GILBERT

CIRCLE 227 READER SERVICE CARD

Want to cut costs on parts like these?

Here's how tracing will help you save

The simple, basic setup shown above handles nearly 300 different parts for a well-known manufacturer of drive line components. All work is performed on one Gisholt MASTERLINE No. 4 Ram Type Turret Lathe with a JETracer on the rear of the cross slide. Standard tools on the hex and square turrets are used to face, chamfer and reduce the stock while the JETracer finishes all diameters, steps, blends and radii. The 6⅜"-long, 2"-diameter stepped shaft (above at left) is typical and is completed in two operations with total f.t.f. time only 4.95 minutes.

Here are just a few things the JETracer can do for you:

- **Shorten setup and change-over time**
- **Simplify machining and eliminate operator errors**
- **Save cost of form tools, multiple tool blocks and holders**
- **Reduce inspection time (only one length and one diameter need checking)**
- **Minimize or eliminate secondary operations (through finer finish, greater accuracy)**
- **Increase production through automatic machining of complex surfaces**
- **Free operator to handle extra units or perform other work**

Gisholt has developed a complete line of JETracers for use with ram and saddle type turret lathes, automatic turret lathes and single-spindle chucking lathes. These include rear cross slide, turret and independent slide mounted units, single or multi-pass types. *All are designed to operate at full capacity of the machines to which they are applied, without limiting machine functions or restricting the use of standard tools.*

You'll want to see for yourself how the JETracer adds flexibility, speeds operations and cuts costs on standard and problem parts. Send the coupon today for your free copy of the new JETracer catalog, or call your Gisholt Representative for complete information.

GISHOLT
MACHINE COMPANY
Madison 10, Wisconsin

ASK YOUR GISHOLT REPRESENTATIVE ABOUT FACTORY-REBUILT MACHINES WITH NEW-MACHINE GUARANTEE

Gisholt Machine Company
1201 E. Washington Ave.
Madison 10, Wisconsin

Please send a copy of the new Gisholt JETracer catalog.

Name.....*Title*.....

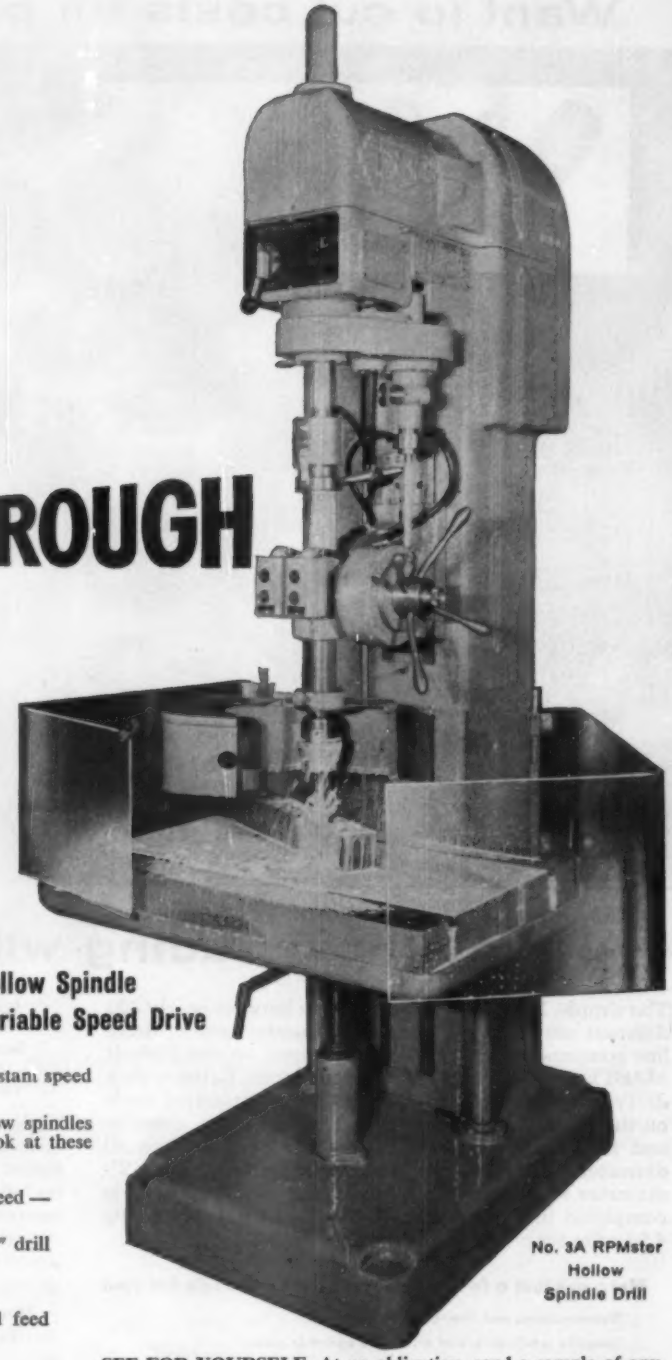
Company.....

Street address.....

City.....*Zone*.....*State*.....

A MAJOR BREAKTHROUGH NOW IN "PROBLEM" DRILLING!

Buffalo RPMster with • Hollow Spindle • Variable Speed Drive



No. 3A RPMster Hollow Spindle Drill

Buffalo pioneered the RPMster's variable speed drive — instant speed changes while drilling.

Now, *Buffalo* brings you the RPMster with special hollow spindles to shatter concepts of formerly "impossible" drilling. Look at these test results:

316 STAINLESS STEEL — ¾″ drill, 700 rpm, .001″ feed — 4″ deep; ½″ drill, 900 rpm, .001″ feed — 4½″ deep.

TOOL STEEL SHEAR BLADES Hardened to 54 R c. ½″ drill — 800 rpm .001″ feed — 2½″ through.

RENE 41 — ½″ hole @ 750 rpm .001″ — 3″ through.

BERYLLIUM BRONZE — ½″ hole @ 6200 rpm hand feed through 2½″ in 1½ seconds.

TITANIUM — ⅜″ hole @ 1000 rpm .002″ feed.

CAST IRON — ¾″ hole @ 2000 rpm. 004″ feed.

52-100 ALLOY STEEL — 7/16″ hole @ 800 rpm .001″ feed.

SEE FOR YOURSELF. At no obligation, send a sample of any hard-to-drill material to the factory. We will test-drill it and return the sample with a report on the drilling tests. Send your sample today, and write for details!

"Buffalo"

BUFFALO FORGE COMPANY

BUFFALO, NEW YORK

Buffalo air handling equipment to move, heat, cool, dehumidify and clean air and other gases.

Buffalo Machine Tools to drill, punch, shear, bend, slit, notch and cope for production or plant maintenance.

Buffalo Centrifugal Pumps to handle most liquids and slurries under a variety of conditions.

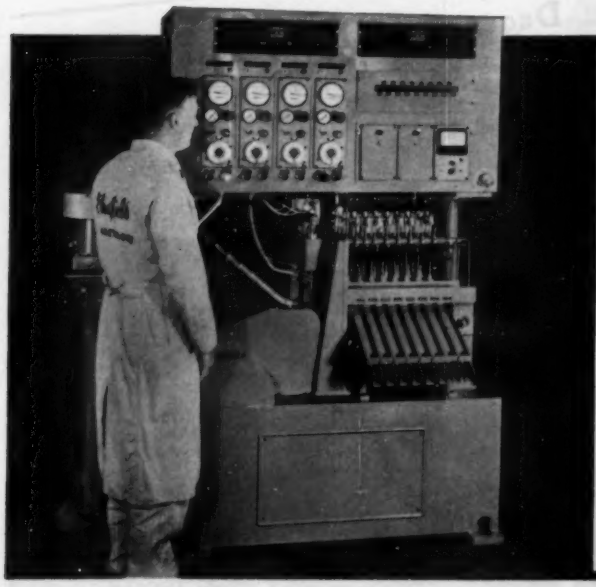
Squier machinery to process sugar cane, coffee and rice. Special processing machinery for chemicals.

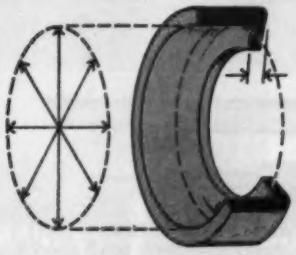
A Sheffield sorter* sorts 2000 rings an hour

2000 rings an hour a Sheffield sorter* sorts.

If a Sheffield sorter* sorts 2000 rings an hour

Where are the 2000 rings the Sheffield sorter* sorts?





*This Sheffield automatic gaging, classifying and segregating machine inspects up to 2,000 rings an hour for the Western Electric Company. It simultaneously measures inside diameter and flange thickness, classifies rings into 15 sizes plus out of tolerance, and rejects each size in its chute. Its speed and accuracy have resulted in appreciable manufacturing savings.

One of them is in your telephone.

Pick it up and call SHEFFIELD for further information on automatic gaging and assembly machines. CL 4-5377, Ext. 211, 212, 213.

The SHEFFIELD Corporation Dayton 1, Ohio

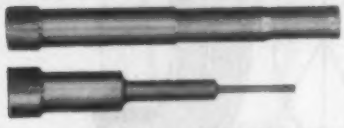
A subsidiary of the Bendix Corporation

Gages, Measuring Instruments, Automatic Gaging & Assembly Systems • Machine Tools • Contract Mfg.

CLEVELAND 1⅝" DIALMATIC

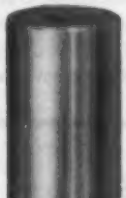
"Increased production 500%", reports Decker Nut Mfg. Corp.

With *dial control* of infinitely variable spindle speeds and turret tool feeds, this 1⅝" Model AB Cleveland Single Spindle Automatic has increased production 500% on close tolerance machining of cold heading tools for Decker Nut Mfg. Corp. Typical tools are shown below. Shown at the machine are R. R. Hunt, foreman, and B. L. Konkle, operator and set-up man.



TOP—Long pierce punch (H. S. Steel) machined in 5 operations. Cleveland time: 20/hr. gross. Lathe time: 7/hr. gross.

BOTTOM — Short pierce punch (H. S. Steel) machined in 6 operations. Cleveland time: 17/hr. gross. Lathe time: 7/hr. gross.



Square die (High C-High Cr Die Steel) machined in 7 operations. Cleveland time: 10/hr. gross. Lathe time: 22 min. each.

Nose die (Cr-W Tool Steel) machined in 7 operations. Cleveland time: 9/hr. gross. Lathe time: 25 min. each.

DECKER NUT MANUFACTURING CORP.
Manufacturers of
COLD HEADED INDUSTRIAL FASTENERS
Albion, Michigan

Cleveland Automatic Machine Company
Cincinnati, 12, Ohio

Gentlemen:- Attention: Mr. Prohaska

The 1-5/8 Dialmatic which we purchased recently has resulted in substantial savings in our toolroom cost. These savings were realized immediately. Where we had been using lathes to make tools for our cold-heading equipment we now use the Dialmatic completely.

The use of this machine has increased production of tools at least 500%. Coupled with the savings in time and labor we have reduced the possibility of human errors to practically nothing. This machine runs exclusively on tool steels at very close tolerances.

Our satisfaction with your equipment would not be complete without mentioning the fine cooperation that we receive from your sales and service people.

Should it be necessary to increase our facilities along this line, your equipment will most certainly be our choice.

Yours very truly,

DECKER NUT MANUFACTURING CORP.,

Edwin W. Konkle

Edwin W. Konkle
Pres. & Gen. Mgr.

EWK/CT

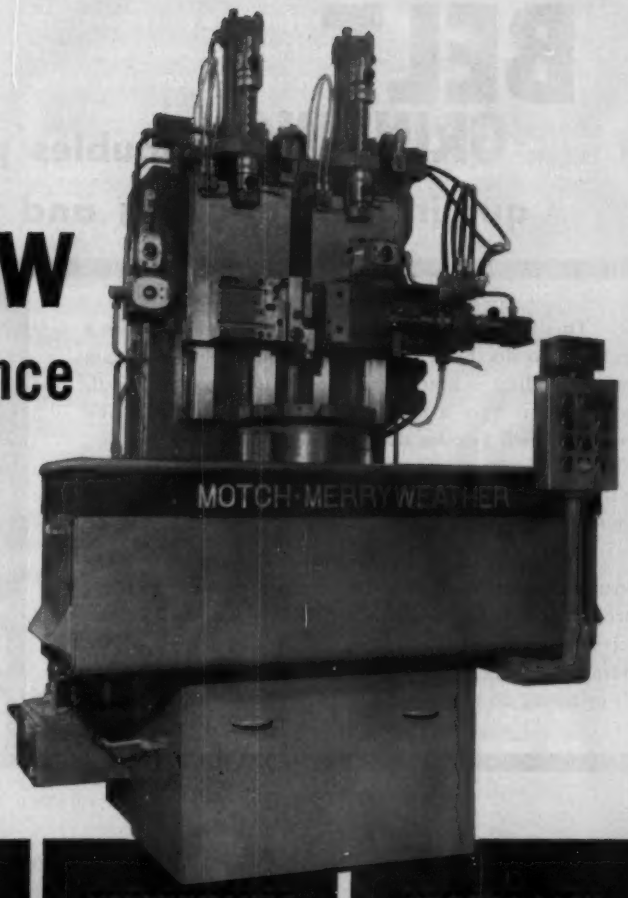
Let a Cleveland field engineer show *you* how *Clevelands Cut Costs!* For machine specifications write for General Bulletin.

Sales Offices: Chicago • Cleveland • Detroit • Hartford • Springfield, N. J.

CLEVELAND AUTOMATIC MACHINE COMPANY
4928 Beech Street • Cincinnati 12, Ohio

Manufacturers of a Complete Line of Single Spindle Automatic Screw Machines and High Pressure Hydraulic Die Casting Machines

NOW a high-performance low-cost Vertical Turner



M & M Vertical Turners offer 3 key advantages in turning, facing, boring and tracing operations

SIMPLICITY

The Vertical Turner is not one machine, but a line of machines designed with standard components. Arrangement of components for a specific job will provide high efficiency at low cost. The machine is built with only the minimum components and accessories you actually require.

PERFORMANCE

The Vertical Turner has the rigidity for heavy roughing cuts and precision finishing. It has the capability for high production or short lot runs. A wide choice of accessories is available.

VERSATILITY

The machines can handle a wide range of multiple operations, programmed with automatic cycle to suit. Tool set-up is simple and quick. The building block concept permits rearrangement of the basic machine in the field to suit job changes.

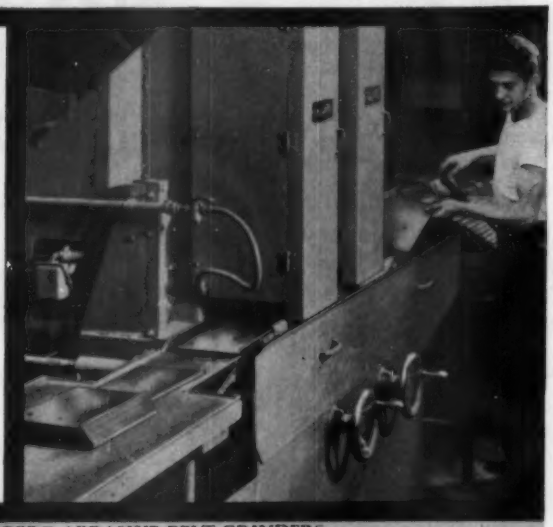
Your local Motch & Merryweather representative has an informative visual presentation of this design concept. For the full story call him, or write Motch & Merryweather Machinery Company, Machine Tool Manufacturing Division, 1250 East 222nd Street, Cleveland 17, Ohio.

MOTCH AND MERRYWEATHER

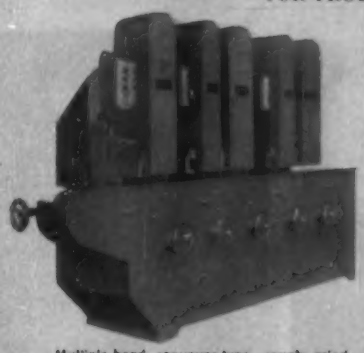
BELT GRINDING: doubles production, improves quality on roughing and finishing operations!

This Sundstrand-Engelberg two-head grinder has a tough job to do. Both sides of a flanged steel base plate require grinding — bottom side needs .002" stock removal, top side must have a uniform 15 microinch finish. The Model 680 belt grinder does the job, day in and day out, at the rate of 500 pieces an hour for the top side, and 475 for the bottom, doubling the speed of former methods. It uses a 120 grit — 320 grit aluminum oxide belt sequence.

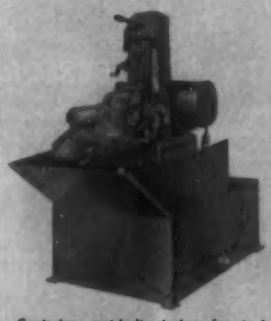
You, too, may be able to drastically improve production and quality on your grinding operations. Send for literature and ask for a Sundstrand "Engineered Production" analysis of your final finishing operations to determine the economic benefits of abrasive belt grinding on your jobs.



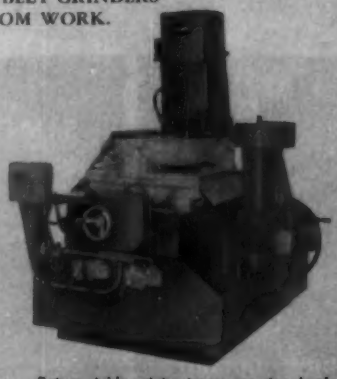
OTHER TYPES OF SUNDSTRAND-ENGELBERG ABRASIVE BELT GRINDERS FOR PRODUCTION, MAINTENANCE, AND TOOLROOM WORK.



Multiple-head conveyor-type—rough grind to final polish in a single pass—any number of heads.



Centerless wet belt grinder—for stock 3/32" to 2-3/4"



Rotary table platen-type—operator loads and unloads without interrupting production.

CHECK THESE FEATURES OF ABRASIVE BELT GRINDING:

Greater production. Because of higher speeds, more grinding area, simpler setups, and no time lost for truing or wheel dressing, production is higher. Belts are sharper due to grain orientation. Flexing works out chips for better cutting edge exposure. Change-over time is reduced to a few minutes. Roughing and polishing can be done with only one setup.

• • •

More versatility. Any material can be machined: metallic or nonmetallic. They're efficient for either mass production, small lots, or toolmaking. They're more easily automated than many other machines.

• • •

Lower cost. Remarkable production lowers costs per piece. You don't need skilled labor for their operation nor elaborate, expensive fixtures. Belt grinders cost less to begin with than most other finishing machines. Also, belts are less expensive than wheels and are much easier to store and handle.

• • •

Simple and safe. Abrasive belt machining is safer because wheel hazards are eliminated. Operator fatigue is reduced and chips present no problems. Belts are easily changed by inexperienced personnel.

SUNDSTRAND ENGELBERG

SUNDSTRAND-AMERICAN BROACH

ANN ARBOR, MICHIGAN • DIVISION OF SUNDSTRAND CORPORATION

CIRCLE 233 READER SERVICE CARD

CIRCLE 234 READER SERVICE CARD ►

ONE pump becomes MANY . . . saving you pump dollars . . . giving you a wide range of clear water, non-clog and other liquid-handling modifications . . . when you standardize your pumping operations with Fairbanks, Morse ADAPT-*ABLE* pumps.

F-M ADAPT-*ABLES* consist of a pump frame and simple adapter to which can be attached a wide variety of F-M hydraulic ends with enclosed, semi-open or non-clog impellers. Conversion is easy . . . inexpensive, too.

F-M ADAPT-*ABLES* are *"NEMA-Matched"*: pump mounting dimensions are standardized with similar dimensions of Nema-driving motors. Gone is the need for make-shift height-adjusting blocks and odd-bore couplings!

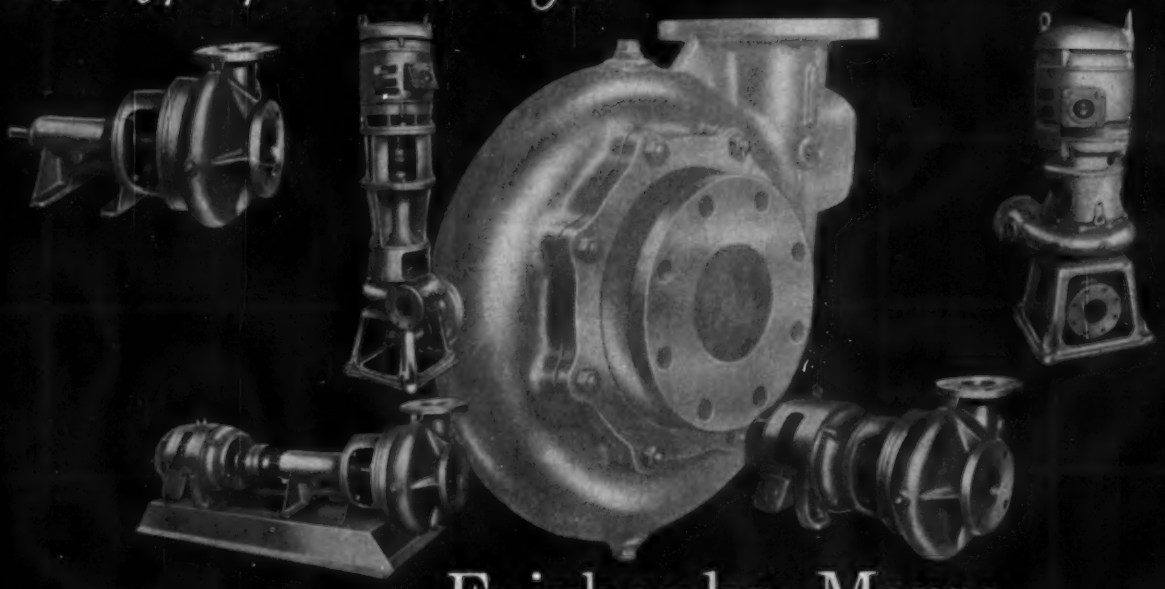
The ADAPT-*ABLE* design means that the most economical frame size may be selected to match the motor horsepower requirements of the pumping job.

And there are other advantages: choice of mechanical seals or conventional stuffing boxes with easy field change-over from one to the other . . . interchangeable bearings for pumps and motors. For special liquid handling problems, hydraulic ends can be specially alloyed to fit the needs: we've been solving such problems for generations.

Regardless of *what* liquids you pump . . . or *where* . . . Fairbanks, Morse builds pumps and *matching* power units for *your* use . . . in a greater range of sizes, types and capacities than *anyone, anywhere*. Start SAVING pump and motor dollars by putting F-M's vast hydraulic experience to work in your plants, process lines and products . . . now!

"nema-matched" *adapt-ables*

. . . a lot of pumps in ONE package!



Fairbanks, Morse

THE PROUDEST NAME IN PUMPS

Pump and Hydraulic Division • Kansas City, Kansas

A MAJOR INDUSTRIAL COMPONENT OF **FAIRBANKS WHITNEY CORPORATION**

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CAPEWELL

is the originator and developer of the revolutionary new L-100-M

SPEED-BAND®

double carbide Band Saws

ONLY

available from authorized CAPEWELL Distributors

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CAPEWELL

THE CAPEWELL MFG. CO.
HARTFORD 2, CONN.

LETTERS

to the editors

330 W 42nd St, New York 36, NY

Hydraulic Clamping

Dear Sirs:
We were greatly interested in your article on hydraulic clamping (*AM/MM*— Feb 8 '60, p106). It was also interesting to note from the picture that they made the same mistake we did.

At the start, we had a good-sized job on the planer, clamped by air. Without any warning the compressor went bad. The clamps let loose and we near wrecked the planer. Fortunately no one was hurt. The same thing can happen with hydraulic clamping.

We still use this method of clamping, but we extended the heel of the clamp and fastened a fail-safe block to it. It may take a few seconds longer to set up, but at least, no one will get killed. PLAY IT SAFE.

Edw C Porsberg
Cleveland, Ohio

The Newton Hydraulic Tooling Co answers reader Porsberg's comments as follows:

The question of safety in all forms of work clamping has long been uppermost in the minds of many tool engineers, ourselves included.

One of the definite advantages of hydraulic clamping, such as that engineered by Newton is that it is a closed *local* circuit, much less prone to accident and controllable to almost any degree considered necessary.

By contrast, air clamping is usually fed from a line common to other air users and at best is subject to pressure fluctuations and at worst to unexpected failure.

In simple hand-pump hydraulic circuits involving one to four cylinders, observation of the pressure gage is adequate warning as failure is most likely to result from minor leaks and occurs quite slowly.

On larger systems many safety precautions are available. For example, the circuit can be divided into two or more branches, each provided with a shut-off valve and each branch energizing cylinders distributed evenly about the workpiece.

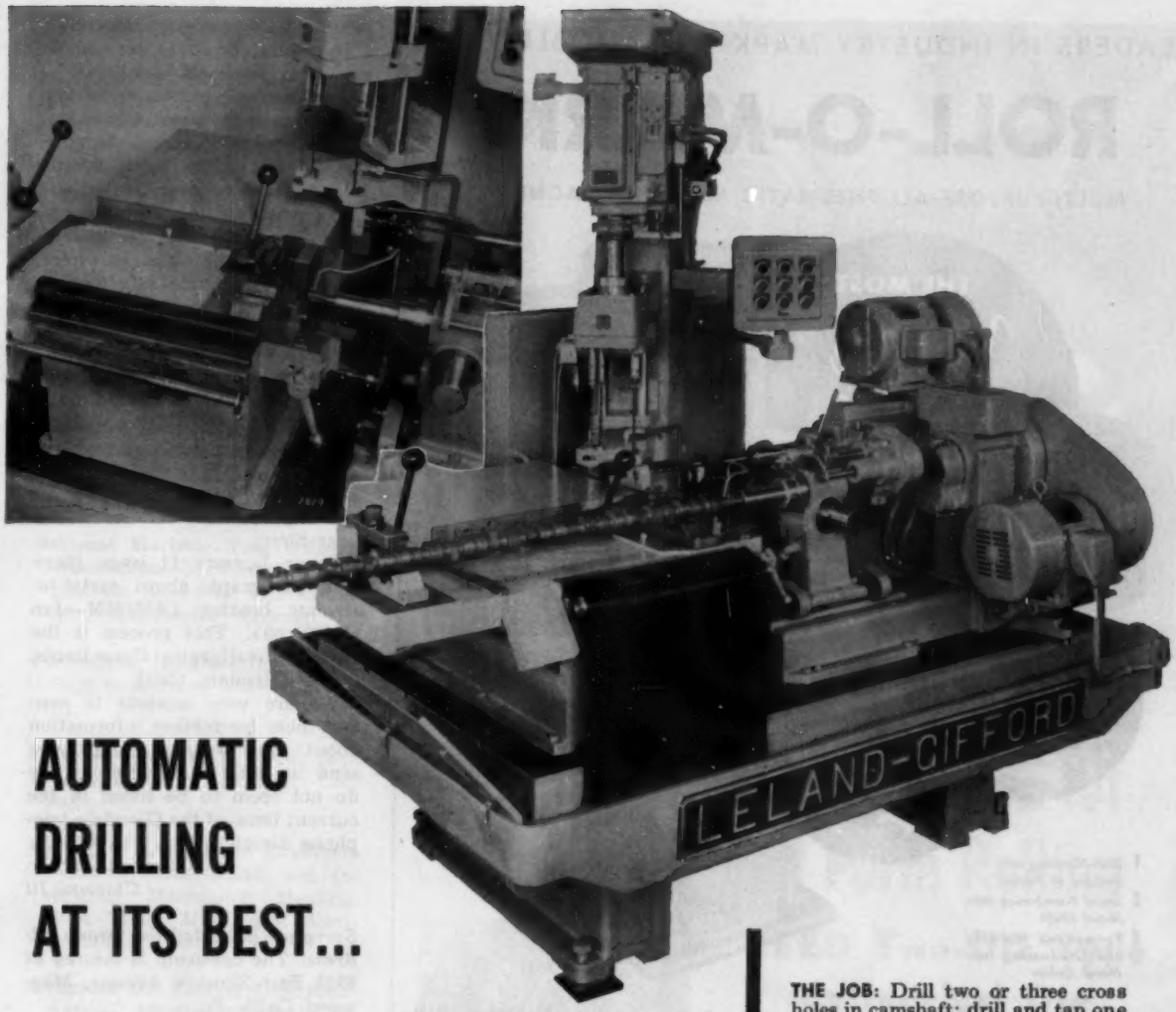
Then, in the event of a leak in one circuit, the adjacent circuit will hold the workpiece adequately until the machine is shut down.

For warning of failure, gages in each branch are often sufficient. More elaborate warning devices such as pressure switches can be

SHOPMATES

N. Jarvis

HIYA MEN!! WHERE DO I HANG MY HAT?? — TAKE ANY EMPTY BENCH?? RIGHT!! SAY··· WHO'S HANDY AT SOLDERIN'?? ANY OF YOU GUYS BRAZE?? GOT ANY RIVITS??
NOT THE FIRST DAY!
N. JARVIS



AUTOMATIC DRILLING AT ITS BEST...

Here is automatic drilling applied to varied production that frequently includes short runs. Designed to handle fourteen different camshafts, this Leland-Gifford special drills an axial hole up to 5¾" deep, taps the axial hole and drills two or three cross holes in each shaft. Typical production for 5/16" axial holes up to 3½" deep, plus cross holes and tapping, is 26 shafts per hour at 100% efficiency including handling. Change-over for different shafts is quick and easy.

Investment in this Leland-Gifford special machine quickly paid for itself.

THE JOB: Drill two or three cross holes in camshaft; drill and tap one deep oil hole in axis of shaft.

THE MACHINE: A Leland-Gifford special with two standard self-contained, step feed drilling units, one standard lead screw tapping unit, and work-handling fixture. Shafts are manually clamped and hydraulically shuttled to drilling position where all drilling units feed until interference point. Vertical unit retracts until horizontal unit completes deep hole, then finishes cross holes. Shaft shuttled to forward position for axial hole tapping.

For automatic drilling at its best, be sure to see Leland-Gifford

CALL THE OFFICE NEAR YOU

LELAND-GIFFORD SPECIAL DRILLING MACHINES

WORCESTER 1, MASSACHUSETTS
U. S. A.

Chicago 5
2515 W. Peterson Ave.

Detroit
10429 W. McNichols Rd.

Cleveland 22
P. O. Box 853

New York Office
75 S. Orange Ave.
South Orange, N.J.

Los Angeles Office
2620 Leonis Blvd.
Vernon 58, Cal.

Indianapolis 6, P. O. Box 1051

Rochester 12, P. O. Box 24, Charlotte Station

LEADERS IN INDUSTRY MARK WITH NOBLEWEST

ROLL-O-MARK

MULTI-PURPOSE ALL-PNEUMATIC MARKING MACHINE

1 *Roll-Marking into Surface of Piston*
2 *Serial Numbering into Metal Shaft*
3 *Permanent Marking and Graduating into Metal Collar*

Model 50P1

This multi-purpose Roll-O-Mark can be set up faster . . . tooled up easier . . . accommodates attachments more readily than any other marking machine. With all-pneumatic operation, no motor or separate power unit is required. Simply connect to the shop's air line—air is used *only* when in operation. This multi-purpose metal marking machine offers many other advantages such as—5" die slide stroke . . . open throat design . . . hand wheel for rapid table elevation . . . independent control for set up.

Whatever your needs for metal marking, Noblewest makes the machines, marking dies, and work-holding fixtures for doing the complete job faster, better, at lower cost. And remember, Noblewest Roll Marking is *permanently* indented marking—*good for the life of your product.* Write for new catalog. The Noble & Westbrook Manufacturing Company, 17 Westbrook Street, East Hartford 8, Conn.

A mark is only as good as the die that made it. Noblewest steel marking dies are precision made for permanently indented marking.

A few desirable territories open to qualified representatives

MARK IT BEST WITH NOBLEWEST IMPROVED MARKING DEVICES

NOBLEWEST

ORIGINATORS OF THE ROLL MARKING PROCESS

MARKING
NUMBERING
EMBOSSING
GRADUATING

provided for remote indication.

In general, however, we emphasize the inherent safety of a closed, local circuit when the system is carefully piped. Obviously, no method of clamping is completely safe. Even the "old-faithful" stud can be overstressed and break when cutting loads are applied. The usual attitudes to safety apply in clamping as elsewhere. A desire to provide safe tooling, backed up by common sense and thought in design and application will provide a safe tool.

David J Milliken, *president*
Newton Hydraulic Tooling Co, Inc
Auburn, Mass

Metal-Ceramic Braze

Dear Sirs:

In your January 11 issue, there is a paragraph about metal-to-ceramic brazing (*AM/MM*—Jan 11 '60, p3). This process is the work of Metallurgical Consultants, Inc., of Glendale, Calif.

We are very anxious to contact them for further information about this process. Could you send us their full address. They do not seem to be listed in the current issue of the Glendale telephone directory.

E G Gilbo
Chicago, Ill

Sorry we indicated the wrong address. The company is located at 4935 East Slauson Avenue, Maywood, Calif—Ed.

"You didn't like it, Dear? That's funny every one at the plant I told that joke to thought it was hilarious."

CALENDAR

Drop Forging Association—Annual Meeting, June 26-29, Seigniory Club, Montebello, Quebec.

American Society for Testing Materials — Annual Meeting and Exhibit, June 26-July 1, Chalfonte-Haddon Hall, Atlantic City, NJ.

National Association of Metal Finishers—Annual Convention, July 22-24, Statler Hilton Hotel, Los Angeles, Calif.

American Machine Tool Distributors Association—Annual Meeting, Sept 3-4, La Salle Hotel, Chicago, Ill.

National Machine Tool Builders Association—Machine Tool Exposition, Sept 6-16, International Amphitheatre, Chicago, Ill.

Production Engineering Show, Sept 6-16, Navy Pier, Chicago, Ill.

Coliseum Machinery Show, Sept 7-15, Chicago Coliseum, Chicago, Ill.

Society of Automotive Engineers—Farm, Construction, and Industrial Machinery Meeting, Sept 12-15, Milwaukee Auditorium, Milwaukee, Wis.

American Die Casting Institute—Annual Meeting, Sept 14-15, Edgewater Beach Hotel, Chicago, Ill

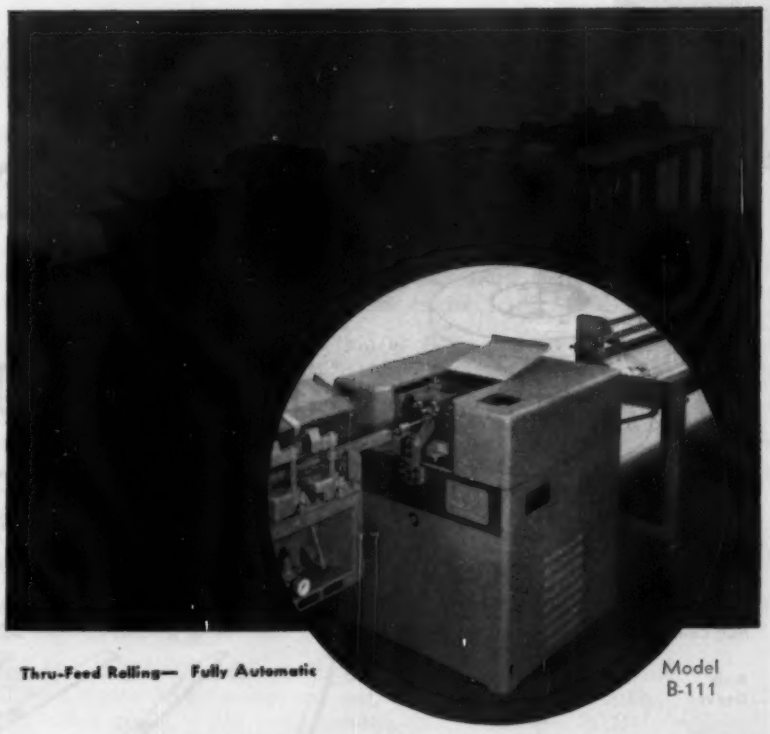
American Welding Society—National Fall Meeting, Sept 26-30, Penn Sheraton Hotel, Pittsburgh, Penna

Instrument Society of America—Instrument-Automation Conference & Exhibit, Sept 26-30, Coliseum, New York, NY

Society of Automotive Engineers—National Aeronautic Meeting and Display, Oct 10-14, The Ambassador, Los Angeles, Calif.

Industrial Management Society—Industrial Engineering and Management Clinic, Oct 13-14, Conrad Hilton Hotel, Chicago, Ill.

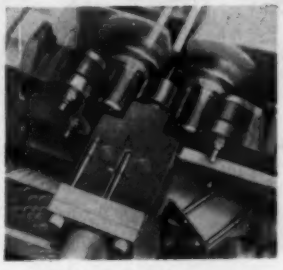
National Safety Council—National Safety Congress, Oct 17-21, Conrad Hilton Hotel, Chicago, Ill.



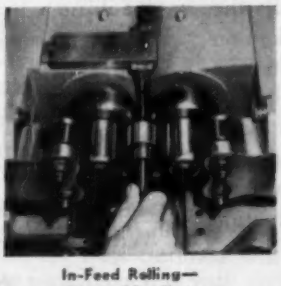
Thru-Feed Rolling— Fully Automatic

Model B-111

.... for Production or Job lot Threading and Form Rolling



In-Feed Rolling— Fully or Semi-Automatic



In-Feed Rolling— Manual loading

REED Two-Die Type Cylindrical Die Thread Rolling Machines

The flexibility of the Reed B-111 machine provides for the most economical selection of equipment to suit job lot or quantity production requirements.

Standard machines are available for in-feed or thru-feed rolling or a combination of both for a wide range of thread and form rolling applications. Precise micrometer die and work positioning adjustments assure continuous production of uniform accurate threads and forms.

Booth 421—Machine Tool Exposition September 6-16, 1960

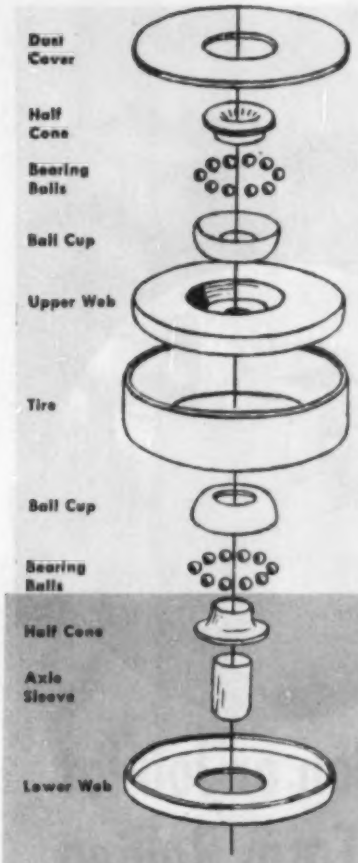
REED TRM-173

REED ROLLED THREAD DIE CO.

Specialists in Thread and Form Rolling Tools and Equipment

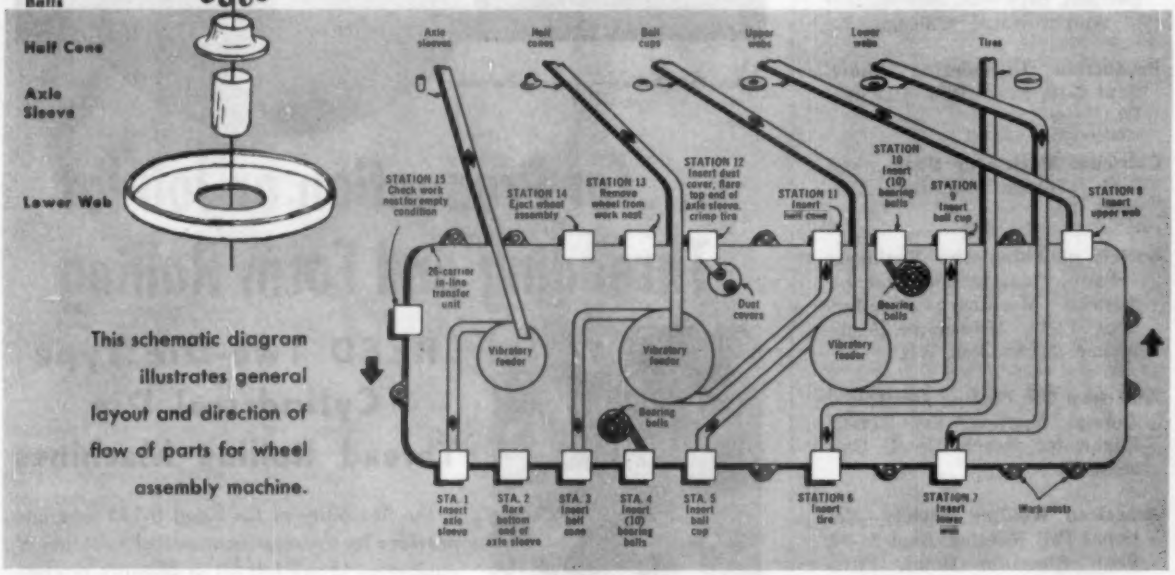
HOLDEN, MASSACHUSETTS, U. S. A.

Sales Offices in: Buffalo, Chicago, Cleveland, Compton, Calif., Denver, Detroit, Englewood, N. J., Houston, Indianapolis, Milwaukee, Montreal, New York City, Phila., Pittsburgh, St. Louis, Syracuse, Toronto



From MULTIPLE PARTS to FINISHED WHEEL in 2 SECONDS

In-Line Transfer Machine assembles Roller Skate Wheels Consisting of 20 Bearing Balls and 9 Other Parts


Axle sleeves
Half cones
Ball cups
Upper webs
Lower webs
Tires
STATION 15 Check work nest for empty condition
STATION 14 Eject wheel assembly
STATION 13 Remove wheel from work nest
STATION 12 Insert dust cover, flare top end of axle sleeve, crimp tire
STATION 11 Insert ball cage
STATION 10 Insert (10) bearing balls
STATION 9 Insert ball cup
STATION 8 Insert upper web
26-carrier in-line transfer unit
Dust covers
Bearing balls
Vibratory feeder
Vibratory feeder
Vibratory feeder
Bearing balls
STA. 1 Insert axle sleeve
STA. 2 Flare bottom end of axle sleeve
STA. 3 Insert half cone
STA. 4 Insert (10) bearing balls
STA. 5 Insert ball cup
STATION 6 Insert tire
STATION 7 Insert lower web
Work nests

This schematic diagram illustrates general layout and direction of flow of parts for wheel assembly machine.

When two types of assemblies require basically the same components there exists an "amplification factor" which adds to the economic justification of automatic assembly. In the case of this in-line transfer machine, thirty ball bearing roller skate wheels are assembled per minute with only one observer-operator. At the end of a run one station is modified and two are shut down for production of another type of skate wheel.

Happy result is an improved position of the manufacturer in the market and greater profit through reduction of manufacturing costs. The Hicks Development Division of Ferguson Machine, offering creative engineering based upon proved methods and principles, designed versatility into this machine which became the deciding factor in achieving feasibility of automatic assembly.

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showing the many things we can do to help you improve automation techniques. Our engineers are ready to help you with any problem. They will start from scratch or redesign present equipment. Write us today.

Hicks Development Division

FERGUSON MACHINE CORPORATION

A subsidiary of Universal Match Corporation

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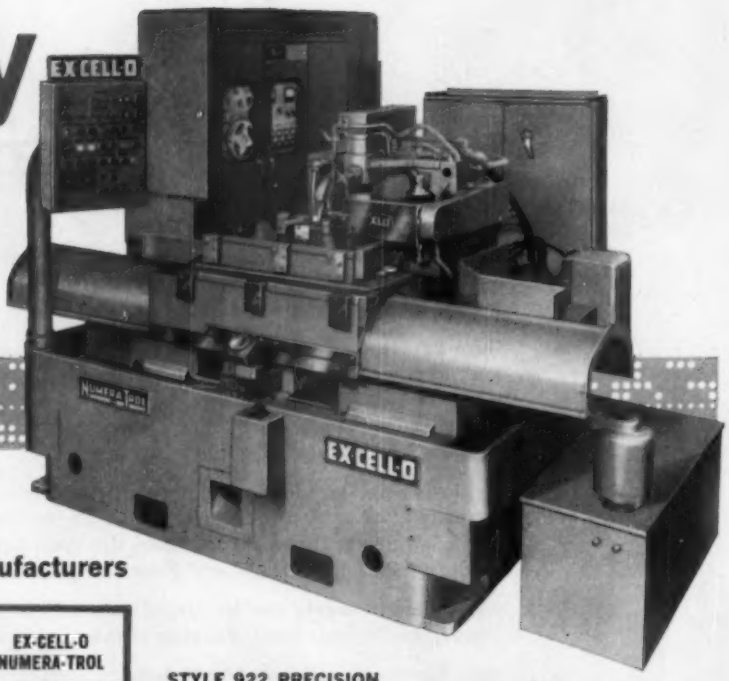
SPOT NEWS...

- **Industry rumors too strong to be denied** have it that Pontiac in 1961 will bring out a 119-in.-wheelbase model to compete with the Dodge Dart. Odds are that it will be powered by a version of GMC's V-6 truck engine.
- **Bare beryllium is being extruded** in pieces as thin as ⅛ in. and up to 29 feet long, reports Norair Division of Northrop Corp, Hawthorne, Calif. Strength runs between 80,000 and 100,000 psi, with an elongation of 6%. Quality is still below expectations. Voids which now appear may be eliminated by further work on alloying and casting of quality ingots.
- **Explosive flaring tool** for heavy-wall stainless tubing will flare ½ to 1¼-in.-dia tubing of wall thickness up to 0.120 in. Firing of a standard crimped-end cartridge drives a conical tool into the open tube end to produce flare. Tool is made by Parker Fittings and Hose Division, Parker Hannifin Corp.
- **Molybdenum ingots can be forged into billets** at temperatures up to 4500 F at Universal-Cyclops Steel. Forging is done in an argon atmosphere. See page 120.
- **East Germany will buy 10,000 tons** of deep-drawing sheet and hot-rolled strip steel from the United States under a contract negotiated by Deutsche Stahl-und Metall-GmbH and a group of US firms headed by Possehl Ore & Metal Corp, New York, and Sutton Steel and Metal Corp. Steel will be delivered this month.
- **Army orders for the SS-11 anti-tank missile** developed by Nord Aviation of France, will be filled by a producer in the U S. Nord tells the Army that a recent West German order for 25,000 missiles has preempted the French company's production capacity. Nord has reportedly selected General Electric as its licensee if the Army agrees.
- **General Motors has confirmed** the names for its forthcoming compact cars. The list includes two surprises—Oldsmobile F-85 and the Buick Special. Pontiac has kept Tempest, as predicted.
- **Air Force is revising its policy for management of weapons systems** in the missile and space fields. In the future, systems engineering and technical direction will be assigned to development or production prime contractors through competition. Space Technology Laboratories will also bow out of its "staff" role in charge of advanced planning and evaluation of new systems.
- **A Russian order for thirty optical rotary and inclinable tables** and a 30-in. automatic, tape-controlled, indexing table has been secured by Optical Measuring Tools Ltd, England.
- **Decarburization depth on forged or cast steel parts** can be measured quickly using standard instruments with a technique developed at Boeing-Wichita. A Rockwell hardness tester is used to apply different indenter loads at the same point on a part. This establishes a relation between decarb depth and hardness of surface layer and core. Depth can be read from a nomograph.
- **West Germans are expected to come up with a new contribution** to electro-erosion machining—an improved dielectric to replace presently used paraffin or silicone fluids. Also, the West Germans will introduce a number of numerically controlled machine tools later this year. Simplified programming is expected to be the major feature.
- **First aircraft manufacturing venture in South America by U S industry** is Aviones Lockheed-Kaiser Argentina, an equal partnership of Industrias Kaiser Argentina and Lockheed Aircraft International. First product will be the light, single-engine utility plane developed by Lockheed for use in Latin America. Factory will be built in Cordoba, 400 miles northwest of Buenos Aires.

a study in time



How Ex-Cell-O Numera-Trol Cuts Costs for Three Modern Manufacturers

Part: TEMPLETS	CONVENTIONAL METHODS	EX-CELL-O NUMERA-TROL
Lead time	128 hrs.	16 hrs.
Grinding per/piece	60 hrs.	6 hrs.
TIME SAVED	166 HOURS	

Part: FUEL CONTROL CAMS	CONVENTIONAL METHODS	EX-CELL-O NUMERA-TROL
Lead time	150 hrs.	40 hrs.
Machining per/piece	80 hrs.	7.5 hrs.
TIME SAVED	182.5 HOURS	

Part: STEAM TURBINE BUCKETS	CONVENTIONAL METHODS	EX-CELL-O NUMERA-TROL
Lead time	144 hrs.	24 hrs.
Machining per/piece	90 hrs.	12 hrs.
TIME SAVED	198 HOURS	

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Slides are controllable to .000025". Grinding unit is interchangeable with boring and turning unit.

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Slashes lead time in producing drum-type cams.

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Performs intricate and accurate milling and grinding of 3-dimensional forms.

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SEE EX-CELL-O'S BOOTH 946, NMTBA EXPOSITION

CIRCLE 240 READER SERVICE CARD

WASHINGTON...

Boost in defense spending . . .

The Senate begins debate this week on the defense budget for fiscal 1961. As the outlook shapes up now, the Senate is expected to tack on some $2 billion to the Administration's appropriation request.

Against the backdrop of the summit collapse, the lawmakers are pushing for a wide-sweeping stepup in military spending.

The most likely increases to be approved: Funds for additional Atlas ICBMs (the Air Force wants $350 million for two more squadrons); B-70 bomber development (AF wants about $185 million extra); even bigger boosts for the Midas and Samos satellites than approved by the House; Army procurement of tanks, tactical missiles, small arms, and other equipment.

The Senate will also back the House addition of $241 million for the Navy's Polaris program (and may even jack up the sum) and $20.7 million for the Air Force's Minuteman. In addition, it's likely the Senate will restore all or some of the $294 million knocked out by the House for the Bomarc missile, all or some of the $293 million killed for an aircraft carrier, and much of the $400 million across-the-board reduction in general military procurement.

The House, traditionally more conservative on federal spending than the Senate, voted $122 million extra for defense. But the House vote came well before the collapse of the summit talks in Paris. In the new atmosphere, the House will probably accept at least half the extra sum to be appropriated by the Senate.

Administration still cool . . .

Despite the fuss for more defense money stirred up in Congress and by the military pros, the Administration's civilian top echelon still opposes a stepup in defense spending. The policy is still to hold military outlays in fiscal 1961 at the $41 billion level set in fiscal 1959 and to be maintained this year.

The official line is this: That U S military strength must be maintained for the long pull, that spending cannot be stepped up for every possible crisis or tapered off for periods of relaxed world tensions.

In the past, the Eisenhower Administration has dragged its feet on the expenditure of extra defense money appropriated by a Democratic-controlled Congress. This time, however, much of the spending will be in the hands of a new Administration.

On the defense spending issue, Republican Nixon has none of Eisenhower's emotional ties to the questions of a balanced budget and a sound dollar which has resulted in the budget holddown.

Defense contracting rising . . .

Even before the debate began on the summit failure, the volume of defense contracting was already on the rise. But there's no summit significance in this. The fourth quarter of any Pentagon fiscal year normally shows a higher rate in contract awards than other seasons.

During the April-June 1960 quarter, the Defense Dept plans to award an average $1.9 billion worth of procurement contracts each month. This compares with $1.5 billion in March and a previous high of $1.8 billion in September 1959.

Trade concession plans . . .

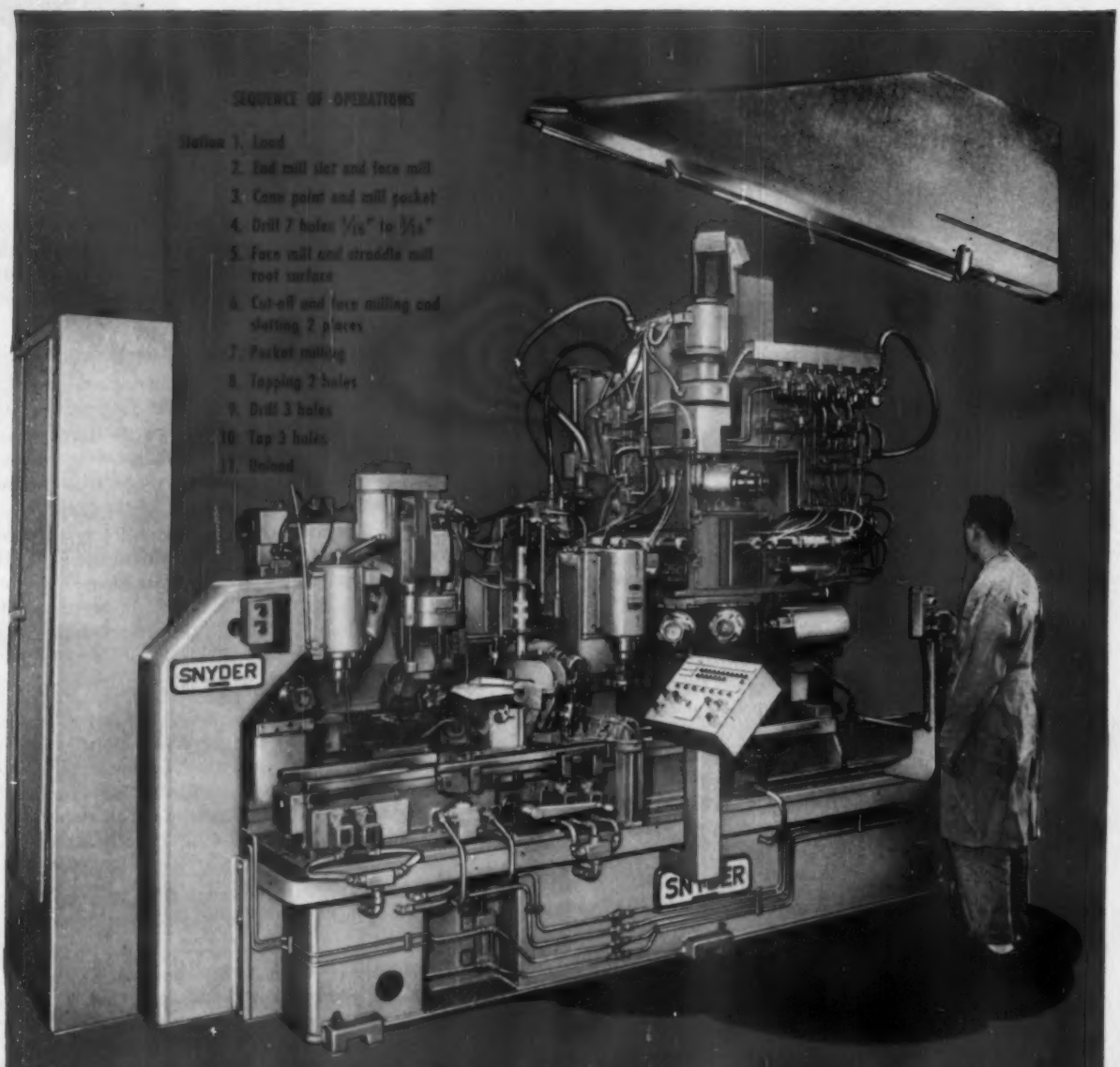
Few machine tools or other industrial equipment items are on the government's list of imports on which further trade concessions will be offered at international negotiating sessions in Geneva next fall, after public hearings at which additions and deletions will be considered.

On the other other hand, Washington's list of exports on which it will ask foreign import concessions from its trading partners is long and inclusive.

The White House is firmly committed to offering as many import concessions as it feels it politically possible in face of election-year domestic protectionist sentiment. The reason: It wants to bargain the lowest possible barriers to U S exports, particularly in western Europe, where government economists fear competition between Europe's two trading blocs will work against U S exports.

Among the import items on which U S negotiators are ready to offer lower duties and restrictions are: certain machine tools, metal balls and rollers, railway wheels, tanks, chains, saws, plates, drills, electrical machinery, machine knives, scientific and laboratory equipment, files, automotive and airplane parts, steam engines, and textile machinery.

Included in the list of products on which U S negotiators will ask foreign concessions are: electrical machinery and apparatus, power generating machinery, construction and mining equipment, metal-cutting and forming tools and parts, textile and sewing machinery, industrial machines and parts, office and printing machines and apparatus.


SEQUENCE OF OPERATIONS
Station 1. Load
2. End mill slot and face mill
3. Cone point and mill pocket
4. Drill 7 holes 1/16" to 3/16"
5. Face mill and straddle mill root surface
6. Cut-off and face milling end slotting 2 places
7. Pocket milling
8. Tapping 2 holes
9. Drill 3 holes
10. Tap 3 holes
11. Unload
SNYDER
SNYDER

COMPLEX MISSILE WING GETS 24 PRECISION OPERATIONS IN SPECIAL SNYDER PROGRAMMING TOOL

at Martin Company's Baltimore Division

Production rate, tolerances and part configuration dictated the fundamental design concept of this exceptionally compact tool which has 11 stations and performs 24 operations.

The cycle can be automatic, semi-automatic or manual. Controls for multiple cycle operations are provided by utilizing basic circuits triggered by a programming control device.

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DETROIT...

Lifetime exhausts...

American Motors Corporation, never known for muffled publicity, has announced that a lifetime exhaust system will be standard equipment on its 1961 models. Rambler owners at least will no longer have to shell out $20-$30 annually for muffler replacement and this, AMC figures, may be just the way to breed more Rambler owners.

Key to the longevity is dipping the muffler and tailpipe in a molten solution of borosilicates, clay, borax, titanium dioxide and other secret refractory agents. This glop, called frit in the trade, adheres to every nook and cranny, inside and out. When fire-hardened at 1500 F, the frit forms a ceramic coating about 0.003 in. thick that tests show to be impervious to attack by road salts and the acids formed from water condensation. The pipe between the muffler and engine is not treated because it runs hot enough to forestall acid formation.

AMC's clucking competitors, whose own research programs were caught idling, hint darkly that the frit does not get into every corner of the complex insides of a muffler, and that corrosion could attack through even minute breaks in the coating.

AMC denies this possibility. Its supplier, Walker Manufacturing Company, worked for three years to come up with a muffler design that would permit fool-proof dipping at a production line pace of over 2000 sets a day. The coating procedure itself was developed by the Bettinger Corporation, a concern long known for its ceramic technology in the coating of aircraft turbine parts.

Original target was to keep the cost penalty down to not more than double what is paid for a conventional aluminized-steel muffler and tailpipe. Compact-car makers currently pay about $2.35 for an aluminized muffler and another $1.07 for a similarly treated tailpipe. According to industry sources, AMC's costs will fall well within the target at a surcharge of about $1.50 a car.

Part of this excess stems from a complicated but necessary trans-shipment of unfinished parts. Mufflers "in white" move from Walker's plant in Jackson, Mich, to Bettinger's coating facility in Toledo. After coating they must be returned to Jackson for asbestos wrapping. Then they are trucked to AMC's assembly plant in Kenosha. Tailpipes are subject to one less move, but they still must go from Racine to Toledo and then back to Kenosha.

If it were one of the Big Three car makers involved, chances are that the complications would be enough to plunge it into the muffler-making business.

By 1962 use of ceramic coated exhaust systems could burgeon. Walker will be released from its obligation as exclusive supplier to AMC, and presumably Bettinger could coat for any other muffler manufacturer. There is also the chance that Big Three manufacturers are not as sleepy as they seem, or in other words, AMC's premature release of a 1961 feature was motivated by the desire for a publicity beat.

Lesson from the past...

Certain repercussions resulting from this corner's costing of the Falcon (*AM/MM*, May 16 '60, p73) prompts reprint of the following from a publication issued by Dodge Brothers in 1924:

"In order to buy intelligently it is obvious that there should be a clear idea of fundamentals. It is therefore imperative that dealers begin at once to acquaint the public with the truth about the manufacture, sale and resale of automobiles. All information which will contribute to the intelligent purchase of cars will, in the long run, benefit manufacturers who build and market automobiles honestly and at a fair margin of profit. . . ."

Pursuing the point...

Others have asked how the Falcon costing picture compares to the Corvair, Valiant and Comet. "Very favorably," is the only possible reply.

Corvair's aluminum, air-cooled rear-engine added to engineering costs and also required a surcharge for new facilities. Corvair, in addition, was given a revamped former truck plant for assembly at Willow Run. All of this boosted the basic cost of the car about $50 higher than the Falcon's $1383. Corvair's financial planning volume was pegged at 110,000 units annually, a pace which is more than being met.

Virgil Exner's snappy styling is expensive to produce and therefore Valiants run Chrysler $120 more than Ford's cost for a Falcon. The surcharge, however, is just about made up in the selling price. Ford's Comet, on the other hand, is the dream of accountants. It rides on the Falcon (because of mechanical and structural similarity) to the point where only 33,000 units needed to be sold to reach the break-even point. To date, 55,484 Comets have been produced, and a third of the 1960-model run is still to go—**Don MacDonald**

it took 35 seconds and 52 years to process this Diesel engine block

And 52 years? Yes, that's how long Greenlee has been building automatic transfer machines. In these years we have helped solve hundreds of widely diversified problems in automatic production. This experience has won exceptionally wide recognition in the automotive industry. That's why much of our business is repeat business from satisfied customers. If you haven't yet worked with us, now is the time to call. We stay on the job all the way . . . from the time of initial planning until the machine is operating at full efficiency.

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CIRCLE 242 READER SERVICE CARD

AIRCRAFT and MISSILES... TRENDS

Defense contracts and red tape . . .

Military procurement regulations discriminate against small industries, say the contractors.

The regulations are fair and equitable, and it is up to the contractor to protect himself by learning the rules and invoking them, say government spokesmen.

These opposed views were brought out at the recent Independent Defense Industries Conference in Los Angeles. Sponsored by the Graduate School of Business Administration at UCLA and the Strategic Industries Association, the conference centered upon three panel discussions—patents and proprietary rights, cost principles, and advertised vs negotiated procurement.

SIA Secretary Robert R Lent accused the government of "acting the role of Fagan" and the prime contractors of "acting as pawns" in usurping proprietary rights. He cited the case of one subcontractor who was adamant about refusing to give away his manufacturing drawings to the prime and was threatened with removal from consideration on all future Air Force bids.

Colonel Harry T Dykman, USAF, Chief, Patents and Royalties Div, Wright-Patterson AFB, though deploring such coercion, pointed out that the Armed Services Procurement Regulations contain the best protection you could want. "If you're asked for proprietary data you can put a price on it and then negotiate a sale," he said.

Lent countered that such negotiation is often unfeasible because the prime, working under a letter of intent rather than a contract, usually does not know precisely what data will be needed and, as a result, must insist on unlimited rights for his own protection.

In defense of letter contracts, Dykman said, "we need the hardware badly and we have to operate that way. The Air Force has to assume that the prime knows whom he's dealing with, what the costs will be, and if unlimited data will be required. The vendor has every right not to sell. But I realize this doesn't help get business."

New cost principles . . .

It is still too early to properly evaluate the DOD contract cost principles (*AM/MM*—Mar 7 '60, p77) which go into effect July 1, said a panel consisting of Cmdr J M Malloy, Supply Corps—USN, Office of Secretary of Defense, I P Grunewald, director of financial planning and control, Lockheed Aircraft, and Cliff Snider, treasurer, Space Electronics Corp.

Grunewald and Snider both voiced the fear, however, that the new document might result in a greater number of costs being disallowed.

Particular criticism had been levelled at the definition of reasonable and allocable costs as contained in the principle on independent research expenses. Malloy gave assurances that the Air Force pattern of sharing in R&D costs on a 50% across-the-board basis would not be followed. Each contract will be studied separately.

There is nothing wrong with what is said in ASPR, but the weakness occurs in how the rules are administered, said Snider.

An Ordnance spokesman, speaking from the floor, rebutted, "we are being criticized about our administration, but the fact is that you contractors don't know what your contracts say and you don't know what's in ASPR."

Snider felt that the new cost principles should specifically exclude companies under a certain size.

Advertised vs negotiated bidding . . .

William T McInarnay, counsel, Senate Small Business Committee, held that advertising produces the widest source development and the lowest price to the government.

Henry Marcheschi, Air Logistics Corp, listed these disadvantages of advertised bidding:

- The more advertising the more confiscation of proprietary data,
- By putting a premium on low price, advertising establishes an incentive which fosters dishonesty,
- The government gets minimum quality goods,
- Advertising is more time consuming.

McInarnay then read from a release quoting Senator George Smathers, chairman of the Government Procurement Subcommittee of SBC, on the appointment of a temporary advisory group to study DOD procurement practices:

"I have witnessed first hand the weakness of the present military procurement procedures. There is a pressing need for basic alterations in the Defense Department's purchasing policies.

"Failure to efficiently utilize America's total industrial capacity for defense has been extremely wasteful in terms of dollars and time . . . Over the past three or four years our great technological and industrial capability—in both large and small business firms—has often run at a fraction of its efficiency because of bumbling Defense Department procurement policies and a plodding, Colonel Blimp style of procedure."

RELIABILITY:

Reason enough to buy LeBlond

Valuable as five fingers on a hand, these five great LeBlond lathes run round the clock, year in, year out, at the Warren, Ohio, shops of Wean Manufacturing Co. Wean has six LeBlonds in all, including the five in the picture, all purchased in the last five years.

The operations they perform are typically job-shop. Lots are small—five parts alike are a big run; materials may vary from hardened steel to copper. Fat mill rolls, long whippy spindles, sturdy stepped shafts—the rugged LeBlonds take them as they come and turn them quickly and accurately, regular as clockwork.

See LeBlond Booth 810 at the Machine Tool Exposition in Chicago, September 6—16. MMT·PE

Much of Wean's output goes into steel mill equipment that can be relied on to hold up under the most exacting requirements—the same steadfast degree of reliability that LeBlond lathe customers expect, and get.

RELIABILITY is a good reason to buy a lathe. It is reason enough to buy LeBlond.

THE R. K. LEBLOND MACHINE TOOL COMPANY
Cincinnati 8, Ohio

LeBLOND *of Cincinnati*

MACHINE TOOLS...

Air Force machine tools surveyed . . .

Machine tools owned by the Air Force and used in contractors' plants are generally of "modern vintage, in good operating condition and are being replaced at a satisfactory rate."

These conclusions have emerged from a study made recently by a four-man committee headed by Ralph E Cross, executive vice president of The Cross Co.

The committee visited 12 major plants having $201 million of Air Force-owned machines. Purpose of the study, initiated by the Air Force, was to assess the conditions of production equipment, measure the rate of replacement and/or turnover of machine tools, decide upon the effectiveness of the Air Force's tool replacement program, and evaluate management of Air Force tools.

Because of rapid changes in weapon system designs and the resulting need to retool for new production runs, the Air Force essentially has a built-in modernization program.

Replacement at $19.2 million rate . . .

The committee concluded that machine replacement in the plants visited has been at a $19.2-million a year rate over the past 2½ years. If continued, this rate will provide a complete turnover (replacement) of machine facilities every 10½ years.

Pentagon's tool replacement and modernization program, based on cost-savings, "is easy to use and generally liked by contractors," the Cross Committee reported. This program should be put into effect in Air Force depots and "other areas where the products produced do not change rapidly."

As Air Force designs become more stable in the future, the committee observed, the Pentagon tool replacement policy should "become more and more useful for keeping machine tools modern."

Most contractors working on jet engine production are running at less than 50%. Hence a large surplus of machine tools exists in this area.

"The preponderance of (jet engine) work is being performed on the newest, most efficient tools," the committee concluded. "Many of the older tools are being declared surplus, and those which are used at all are used sparingly. Because of these conditions, there will be very little replacement in jet engine plants for many years."

Builders announce new models . . .

Many machine tools builders have decided to reveal their newly-designed machines well in advance of the Machine Tool Exposition-1960 in September at Chicago. In this way they hope to break down sales resistance based on the premise that "we had better wait until the show to place our orders."

Cincinnati Milling Machine Co was the first to display to customers many of its new machines, when it staged its 75th Anniversary celebration at its own plant last October.

Bullard introduced its new major line of machines at the beginning of the year.

Pratt & Whitney observed its centennial with a show at West Hartford last month. It opened its new Centennial Hall by showing an extensive line of new machines to hundreds of customers over a two-weeks' period.

Warner & Swasey, on June 1, dedicated its new research facilities at Solon, Ohio, a Cleveland suburb, and unveiled to the press and public its machines that will be shown at Chicago.

Warner & Swasey's total sales this year still should be around $62 million, president Walter K Bailey, states. Of that amount, about $35 million will be machine tools. This estimate is in spite of the fact that new orders declined in May.

To set minimum-wage rates . . .

U S Department of Labor met with representatives of machine tool builders and unions in Washington recently as the first stage in determination of a minimum wage rate for the machine tool industry under the Walsh-Healey Act. This law requires all contractors dealing with the federal government to pay the prevailing minimum wage on all work done in filling government orders.

The conference was called to go over a proposed wage-rate questionnaire to be sent to machine tool plants. It is estimated that the machine tool industry's minimum wage rate will not be set until well into 1961.

The sequence of events will be: the survey itself, a public hearing on the survey's findings, a tentative decision by the Secretary of Labor, possibly another hearing, and then the final decision.

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MATERIALS...

Fluid muscles for tomorrow...

Future aircraft hydraulic systems will operate at 4000 psi and at temperatures up to 750 F. Equipment must operate with fire-resistant fluids and synthetic gaskets and seals because of the high temperatures. Speeds of small piston pumps will increase to 24,000 rpm. Pump power requirements will increase to above 2000 hp for all of the pumps operating at one time to serve a large supersonic bomber such as the B-70.

These are the conclusions of Edward I Brown, Director of Engineering, Machinery Hydraulics Div, Vickers Incorporated, Detroit, in a paper at the ASME Design Engineering Conference in New York. In the mobile field, he says, hydrostatic transmissions will be developed and used on off-the-road machinery because of higher efficiency and better control than hydrokinetic transmissions.

Mobile auxiliary system pressures may rise above the 2000-psi range and pump speeds should exceed the 4500-rpm range. Central hydraulic systems look promising for both off-the-road machinery and automotive equipment. Controls such as electro-hydraulic servo valves will make mobile equipment more sophisticated; will provide more automatic operation, servo-assisted manipulation, and full-range remote control.

One of the most notable trends in this field is the increase in horsepower output per given space occupied by the pump. Gains in output from a single envelope (or power package) are as high as 300%.

In the industrial field, an accelerating trend right now is toward fire-resistant fluids for hazardous applications. Lower-cost fluids, such as the water-emulsions, will further encourage this trend. Electro-hydraulic systems for machine-tool control are receiving exceptional attention as the automation, and numerical control concepts mushroom. The process industries, together with metalworking, are moving toward electro-hydraulic systems as answers to combining the brain of electronics with the muscle of hydraulics. These systems also provide high-speed response.

Hydraulic adjustable-speed drives, says Mr Brown, will find increasing acceptance over electrical and mechanical adjustable-speed drives because of better response, and precise control characteristics. These factors will open doors for hydraulic power in application heretofore entirely in the realm of mechanical power. Spindle drives are typical in this category. Cost, as well as reliability and serviceability, will benefit from a much broader degree of standardization now underway. Mr Brown believes that hydraulics, and electro-hydraulics particularly, is entering the greatest and most challenging era in its history.

Explosive powder compacting...

Following on the heels of explosive welding, explosive forging, and explosive hardening, research now is underway in several quarters to develop explosive compacting of metal powders into mechanical parts.

Compacted powder materials, such as titanium and steel, have produced densities of more than 95% of theoretical without a sintering operation. The technique is expected to create a new branch of powder metallurgy using high pressure rather than high temperature—or a combination of both. Densities described above were produced in a double-acting explosive press in work sponsored by the US Navy.

Missile "fallout of hardware"...

Most significant throughout both the Design Engineering Conference and the Show was the collapse of time in materials and component development brought on by the space race. Missile systems, says Elmer P Wheaton, vice president, engineering, Missile and Space Systems, Douglas Aircraft Co, are resulting in a "fallout of hardware." A typical example is the frictionless bearing. Passenger luggage conveyors at airports, called Glideair and built by Douglas, will use the air-bearing principle.

Auxiliary power supply sources will have many non-missile uses. Fuel cells, he predicted, will be practical for wide application long before portable nuclear power plants. In other areas, space problems have taught us to design materials for more efficient use and to develop components to suit needs rather than habits. The "systems concept" itself is an important contribution to our industrial economy. Instead of narrow interests, engineers are studying all aspects of a product during its development.

Bearing development...

First off-the-shelf bearings to support a shaft on a hydro-dynamic oil film were displayed at the Design Show. They are called "Hy-Film" and are produced by Tann Corp, Detroit. Oil is drawn from a reservoir of self-wicking material, called Permawick, through bearing windows.

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WHAT'S AHEAD... in Metalworking

TRENDS

Metalworking sees good third and fourth quarters...

Machinery builders anticipate good third and fourth quarters, with new orders coming at a considerably better pace than during the similar periods of 1959. This is the indication given in the latest Machinery New Orders Forecast prepared by McGraw-Hill's Department of Economics. For a detailed breakdown of the forecast and a brief analysis, see page 113.

There has been little change in the general metalworking outlook in recent weeks, though several segments of the industry are beginning to show some optimism. No one is expecting the boom that had been anticipated earlier, but 1960 could still be one of metalworking's best years.

Steel production, which has been dropping off for the past three months, is expected to hit its low point in the first two weeks of June, according to some industry observers. The operating rate will then increase in July, increase further in August, but there will be no dramatic spurt.

Plumbing equipment manufacturers are optimistic over the business outlook. Major concerns report business up 5 to 15% over last year at this time (one reports a slight decline), and the outlook is for 1960 to be up 5 to 8% over 1959.

The Industrial Fasteners Institute reports a drop of eleven points in its shipments index. This continued decline indicates lower production rates in user industries.

Industrial lift truck sales have been running ahead of last year's pace, but some of this increase probably can be attributed to orders deferred until this year because of the steel strike. Sales for the year are expected to be 4 to 5% higher than in 1959.

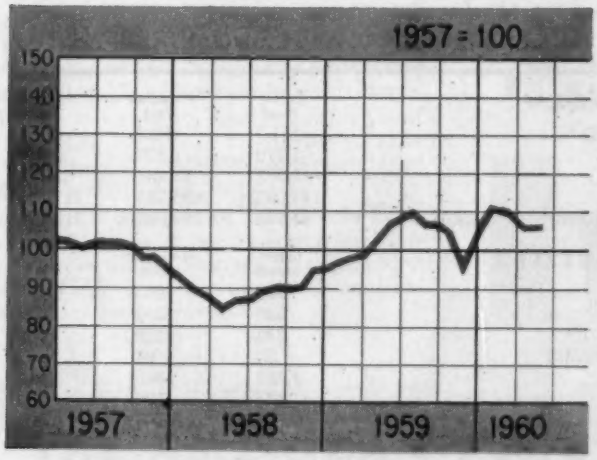
Production and sales of small and fhp motors seem to have reached a levelling-off point. Manufacturers see no upsurge ahead, but business should remain good. Several developments are expected to help small motor producers: new ways to ventilate these motors, better insulation and weather-proofing, and improved control systems, all these will add flexibility to motor application.

Orders for screw machine products continue to decline, according to the National Screw Machine Products Association. Shipments are also down. These declines had been anticipated.

Farm machinery sales have picked up with the improvement in weather, and are generally at high levels. However, a late season "usually means that a good many sales are lost for that year rather than merely deferred."

Industrial furnace manufacturers report good business. Two major concerns report business up more than 10% over last year this time. One, after a slow April, a normal May, expects an exceptionally good June and a year on a par with 1959. Another manufacturer, now running 20% below 1959, reports a steadily increasing business pickup.

Producers of auto parts are faced with a declining rate of orders, reflecting the bullish ordering on the part of the automakers during the first quarter of the year. Parts producers, who will be working on the new models by July or August, look for a pickup in production and orders by that time, but not before.

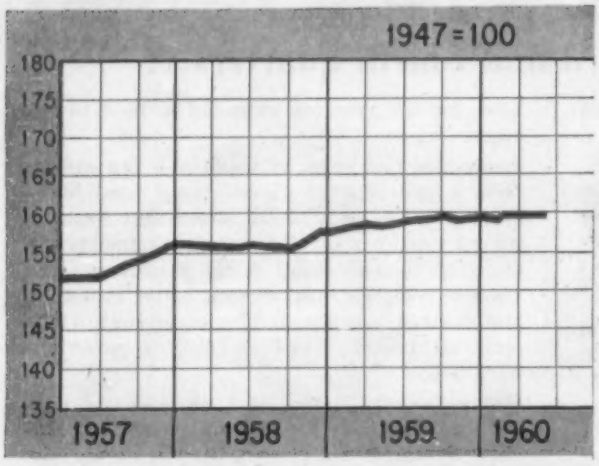


AMERICAN MACHINIST INDEX OF METALWORKING PRODUCTION

BASED ON MANHOURS WORKED IN THE FIVE COMPONENTS

	MAY Estimated	APR. Preliminary	MAR. Revised	APR. Year Ago
Total Index	**105**	**105**	**107**	**105**
Electrical Machinery		104	104	97
Machinery		113	115	103
Autos		116	118	108
Other Transportation		88	87	95
Other Metalworking .		107	110	105

TRENDS WHAT'S AHEAD... in Business



AMERICAN MACHINIST INDEX OF METALWORKING PRICES

	MAY Estimated	APR. Preliminary	MAR. Revised	APR. Year Ago
Total Index	**159.8**	**159.8**	**159.7**	**158.7**
Metalworking Machinery	**190.4**	**190.4**	**184.2**	
Other Machinery exc. Electrical	**173.0**	**172.6**	**169.6**	
Electrical Machinery	**162.3**	**162.2**	**159.3**	
Fabricated Metal Products	**147.9**	**148.0**	**148.8**	

Business at the mid-year mark...

Business sentiment has swayed widely during the first six months of the year. Doubtless, a good part of the shift in attitudes has developed because 1960 has turned out quite different from the early forecasts. But don't lose sight of the fact that 1960 so far has brought record levels of business. True, some businessmen haven't done as well as anticipated. Others, however, have done better than they had hoped to do.

Consumers during the first half of the yead did not spend at the rate business forecasters had predicted. Spending for consumer durable items was up to 5% above the level for the first half of 1959. That's a sizable increase. But better gains had been expected in this area. Thus sales of autos and many appliances, though good, have fallen short of expectations.

Similarly, businessmen haven't built up their inventories at the pace expected. The rate of inventory building has actually declined steadily from the high level of January, whereas forecasts indicated that inventories would grow at an increasing rate into the second quarter of the year. As a result, business hasn't surged upward as rapidly as expected.

Exports of U S goods, on the other hand, have picked up sharply in recent months. And the construction industry has been faring better than had been anticipated.

On balance, business during these first six months of 1960 has been good enough to send the gross national product (the overall measure of business activity) up to $502 billion—about 5% ahead of the bustling first half of last year.

Meanwhile, machinery new orders are coming in at a far better clip than in the final months of 1959. And the latest McGraw-Hill forecast indicates that further improvements lie ahead. Also, industrial construction contract awards are running well ahead of a year ago. So there are strong indications that businessmen are going through with spending plans. Thus business can only improve.

WEEKLY BUSINESS INDICATORS

	Latest Week	Preceding Week	Year Ago
Business Week Index of Activity (1947-49=100)*	151.7	152.8	154.7
Steel ingot production (thousand tons)	1,776	1,870	2,653
Electric power output (million Kilowatt hours)	13,572	13,468	12,778
Production of automobiles	144,092	155,755	117,372
Engineering construction awards (Eng. News-Record, thousands)	64,992	389,087	315,724

MONTHLY BUSINESS INDICATORS

	Latest Month	Preceding Month	Year Ago
Refrigerators sales (thousands of units)	338	302	337
Vacuum cleaners sales (thousand of units)	340	294	347
Washers sales (thousands of units)	244	222	330
Household electric ranges sales (thousands of units)	86	84	102
Radio production (thousands of units)	1,361	845	1,348
Television production (thousands of units)	422	503	494
Gear sales index (1947-49=100)	231.8	278.6	234.3
Foundry equipment new orders index (shipments, 1947-49=100)	159.9	128.6	166.6

* Seasonally adjusted

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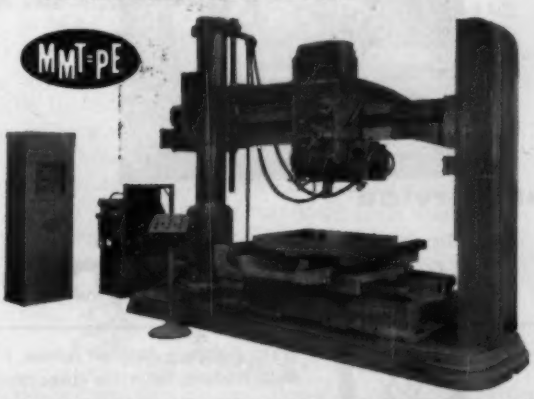

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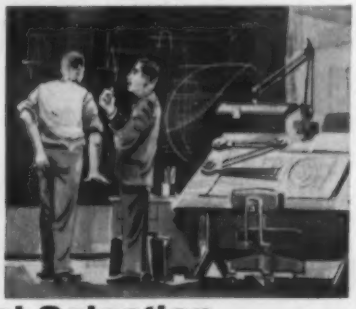

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American Machinist / Metalworking Manufacturing ESTABLISHED 1877

Don't Get Run Down From Behind

American industry is suffering from too much capacity. And Metalworking is no exception.

Too much capacity can cause big headaches. One of them is disastrous price cutting. Manufacturers, fuming over a considerable amount of idle facilities, bid low on orders to keep as much as possible of their factories running. These bids often are at cost or below.

Price cutting, in the end...

benefits no one. If seriously indulged in, it leads to casualties among individual companies and, if carried far enough, to a weakened industry.

There is some virtue, however, in the existence of too much capacity. When order books are overflowing, contentment with things as they are sets in. The urge to improve disappears.

Such an attitude in the face of too much capacity is an invitation to trouble. It could even be fatal. For too much capacity can, and frequently does, lead to the development of new, hot products, to finding new applications for old products, to inventing and applying new techniques that result in major cost-savings and in lowering the product price.

That is what's happening...

as the decade of the 1960s gets under way. A vast array of new products is destined to come onto the market. Some of these new products are the culmination of painstaking and expensive research and development programs. Even more of them have probably been sparked by the compulsion to find a new use for that extra capacity that management stares at day by day.

Whatever the reasons, competition throughout the metalworking industries is becoming more complex as well as more intense. Metal-cutting processes are vying with each other more than ever for the customer's order. At the same time, these processes are in deadly competition with metal-forming techniques.

Perhaps the quickening of competition between one industry and another is the most significant trend of all, as the Machinery and Allied Products Institute recently pointed out in its Capital Goods Review. Product lines are being crossed within and between industries. The "battle of the metals," for example is being waged for new as well as established markets.

Another factor, aside from too much capacity, has been increasingly injecting itself into the competitive situation in Metalworking. It is what might be termed "the global concept."

This sounds pretty high-faluting...

to be sure. But it adds up to this truth: Progressive management can no longer afford to think in terms of its domestic market alone, or its foreign market alone. It must do its planning on the basis of the domestic and foreign markets as an entity.

Engineering, manufacturing and marketing plans must take into consideration the company's world view. Even if a company has no foreign business, and does not want any, it still cannot afford to neglect the world aspect. It is likely to be in competition with imported goods here.

No matter what its motivation, whether to try to keep a huge capacity busy by diversifying or by bringing out new or redesigned products, metalworking management will have to be fast on its feet in the months and years ahead.

There was a day when a company could operate almost indefinitely on half its cylinders and get along. But it sure can't poke along from now on without being run down from behind by ambitious competitors in these times of high minimum speed limits.

Burnham Finney EDITOR

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Multiple-spindle heads and workholding fixtures on this six-station transfer line for machining cast iron housings can be interchanged for a new job setup in less than 10 manhours.

Conveyor loop carries pallets from final station on line (far right) through washing machine (background) to unload-reload station in front of operator (left)

Quick-change heads and workholding fixtures make this a...

Transfer line for short runs

By Ben C Brosheer, associate editor

Transfer machines don't have to be limited to long runs of identical parts. Proof of this is Sundstrand Machine Tool Co's new six-station transfer line, which drills, spotfaces, bores and taps five different-but-related precision cast iron housings for hydraulic units. Small lots are the specialty of this setup—and it's all done with quickly interchangeable multiple-spindle heads and work-locating fixtures.

For example, milling and precision boring heads may be substituted for the horizontal heads, or they may be added on to the line. And while the present machine is arranged only to work from opposing sides, the same concept can be applied to operations requiring vertical heads to work the third (top) side.

Each of the machine's six horizontal slides carries two conventional heads, which drive multi-spindle heads for two adjacent work stations. Pick-off gears for each drive unit provide a spindle speed range of 200 to 2700 rpm.

In each case, saddle feed and traverse is powered by a 1-hp motor feed box with pick-off gears, and the saddles have easily changed positive stops to allow dwell during spotfacing operations. Graduated scales facilitate setting of saddle control dogs when jobs are changed.

The line's multiple-spindle heads are attached to gear drive units with four bolts and keepers, thus providing for quick interchange between setups. Each head has an integrally attached spring-loaded bushing plate, which stays with the head when it is removed from the drive box and stored between setups.

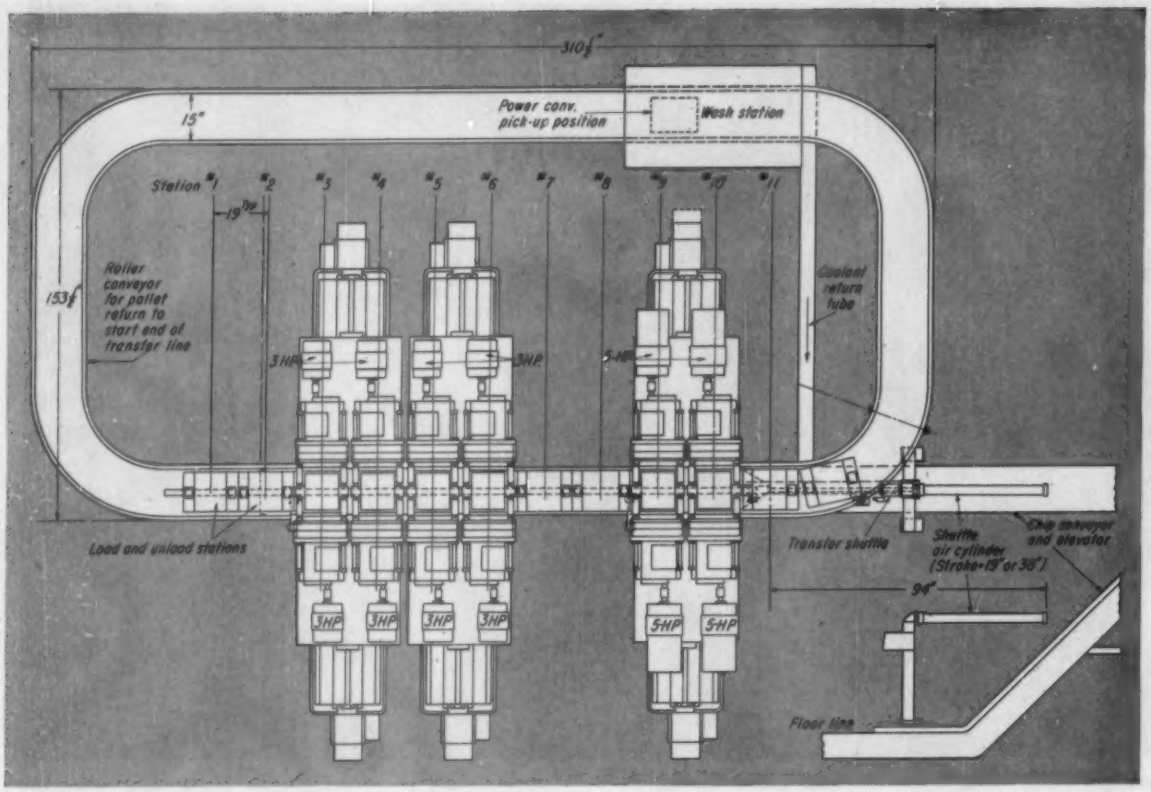
At the customer's plant, the Sundstrand transfer line is provided with a trolley-mounted hoist and a multi-level storage rack to simplify interchange and storage of the multiple-spindle heads.

With this arrangement, two men regularly change the complete macine setup—including interchange of 12 pallet-supported fixtures and 12 heads—in less than five hours.

Handles families of parts

Locating, holding and transferring a whole family of parts has been given top consideration in design of the line. This is done with a set of transfer pallets that can be precisely located at each work station, and upon which workholding fixtures are mounted.

Each pallet has a hardened and ground steel base plate with two hardened precision bushings. Upper



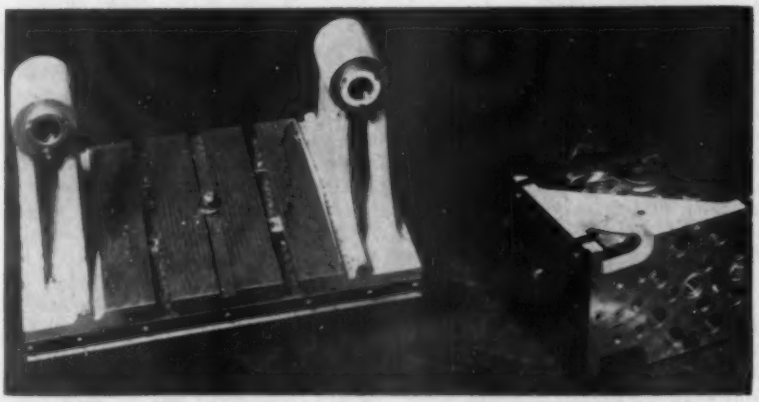
Sundstrand six-station line has an air-cylinder-powered transfer bar which can be set for 19 or 38-inch stroke for single-station or double-station cycling—allowing half the stations to be used for simple jobs requiring only a few spindles, while the other stations idle or are set up for a similar job. Or all the stations may be used at once, to double output of simple jobs, or completely tool a more complex job. The line is served by a central cutting fluid system, and by an underfloor chip conveyor which is equipped with an elevator (lower right in sketch)

part of the pallet is a small precision table, on the supper surface of which are two T slots, an accurate central keyway, and a central diamond-shaped dowel accurately located with relation to bushing plate pilots and clamping surfaces.

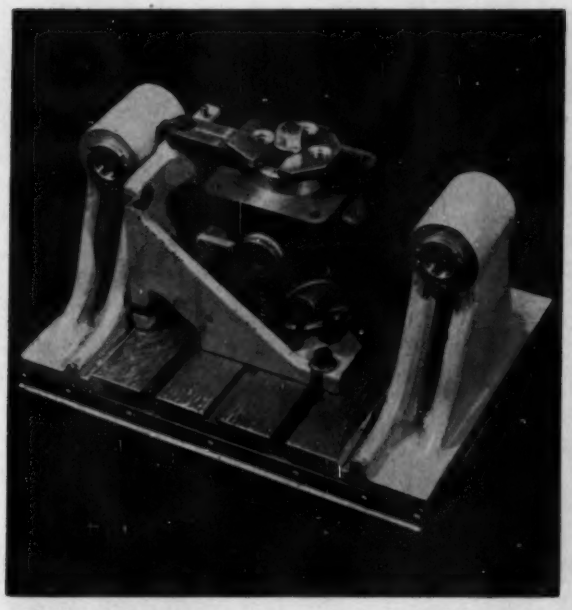
A pallet is pulled or pushed along rails by the transfer mechanism until it reaches its assigned location. Then two dowels automatically penetrate the bushings in the pallet base, locating it longitudinally. Four hydraulic cylinders then push the pallet (on which holding fixtures and the work are mounted) upward, locating it vertically by holding the top face of the pallet against hardened and ground horizontal stops. Horizontal guide pins on the tool heads then enter guide bushings at the top of integral brackets on the end of each pallet.

In this way, the bottom of the base plate is subject to wear as the pallet moves to and from the job on rails. The top surface of the pallet, on the other hand, isn't subject to sliding wear at all. Because of this, the top surface can be so precisely aligned that tool life is greatly increased.

Workholding fixtures can be mounted on the pallet quickly and easily (using the T slots, keyway, and dowel) to suit individual jobs. This flexible setup cuts down on the cost of retooling for a change in product design, or of retooling for a completely new product.



Pallet-mounted fixtures are easily interchanged, are designed for precise positioning at each work station. Fixtures (right) can be made with single or multiple (as shown) base surfaces, each fitted with a centering bushing and alignment keys. T slots in face of pallet are for fixture hold-down bolts



Multi-base fixtures increase the transfer line's flexibility, make it possible to machine different surfaces on the same parts simply by repositioning the fixtures on the pallets, mounting different heads on the slides, and running the parts through the line again. Setups shown are for processing cast iron housings in vertical (left) and horizontal (right) positions. In the Sundstrand line, this can be done on alternate pallets if necessary

Multiple-spindle heads can quickly be interchanged with this overhead hoist suspended from a trolley rail. Each head has a permanently mounted, spring-loaded bushing plate, equipped with tubes to direct cutting fluid to each spindle. Idle heads are stored in nearby rack

Roller-skate wheel rails support plywood pallets on which multiple-spindle heads are stored when not in use. Usually, all the heads for a given setup are stored on a separate row in the rack, so that changes in setup aren't delayed by misplaced heads

Typewriter output gets a lift from two assembly ideas as...

Part handling goes automatic

Two different approaches to mechanized parts handling show two different stages on the road toward full automation at Remington Rand's Elmira, N Y, plant. One development is a fairly straightforward rotary table on which type is aligned and soldered to typewriter bars. The other is a mechanized coining press combined with trimming, milling, and deburring for adding-machine type.

The soldering setup is designed for speed, but also for accurate type alignment—a critical point in typewriters. An operator picks a matrix plate from a rack (to her right in photo), inserts it in a fixture on the rotary table, then places a type slug and type bar to match. The matrix plate is simply an insert in the fixture that will position the type in relation to the typwriter segment (slotted base) and bar.

Operator aligns type slug and bar on matrix plate (from rack at right). Bar length and bend angle must match type character, as does matrix plate

Solder fed automatically

The table indexes, and the type and bar are positioned between gas heating jets. Solder is fed automatically to the joint by roller feed from a reel. Remaining table stations are for cooling and unloading the work.

The solder is 3565 alloy with a melting temperature of approx 350 F.

Next time around, the operator flips the type and bar out of the way, replaces the matrix plate with another for a different type character, and loads another type bar and slug.

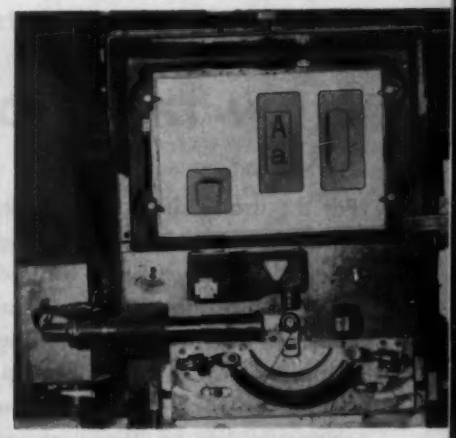
Table rotates at 2 rpm, and makes 44 revolutions until four segments are completed.

Optical checking

Assembled type in segments is checked for position and alignment at special optical comparators developed jointly by RemRand and Bausch & Lomb. A segment is loaded on a fixture, then each type bar is raised to viewing position where three separate light paths carry shadows to one screen. These show face, profile, and top simultaneously. The inspection station also can detect such defects as broken or malformed type.

Automated press

Adding-machine type is formed in rolling dies at a new machine capable of producing at 2000/hour. Rolling is fundamentally the same as handled by older, less mechanized setups, but the integrated press also trims flash and mills side contours on the small bars of AISI 1006 steel. Type slugs feed down a track from a hopper into the rolling dies—which must be changed once per shift. After the characters are formed, the slugs are air-blown from the dies to slide down a second track to a trimming station. A milling attachment cuts the bars so they will fit control levers in the adding machine, and a brushing station removes burrs from the bars.



Shadowgraph checks type in working position with three images

Automatic soldering station joins bar and slug. Rolls feed solder of predetermined amount. Typewriter segment is slotted base in rear, to which type bar is anchored

Metalworking machinery orders to reach peak in fourth quarter

(1950 = 100) Total Machinery

1959	Unadjusted	Seasonally Adjusted	Pumps & Compressors	Engines & Turbines	Construction & Mining Mach.	Metalworking Machinery	Office Machinery	Other Ind. Machinery
I Q	176	168	233	197	196	150	196	163
II Q	185	177	252	208	215	190	197	164
III Q	162	178	207	182	193	172	166	143
IV Q	156	156	230	162	168	182	195	131
1960								
I Q	177	169	327	161	193	168	220	154
II Q*	190	185	356	178	205	201	239	159
III Q*	187	196	342	162	193	167	235	169
IV Q*	180	185	314	153	187	209	255	150
1961								
I Q*	177	169	319	153	191	179	240	150

*Forecast made in mid-April 1960

New orders for metalworking machinery are expected to be 7% higher in 1960 than in 1959, and orders should reach a peak in the fourth quarter. Orders placed on new machines shown at the Machine Tool Exposition will swell the order index to 209 (1950 = 100).

The picture for the machinery industry in general is brighter now than when McGraw-Hill's Department of Economics prepared its previous Machinery New Orders Forecast three months ago. The rise in new business is expected to continue through the third quarter of this year and taper off slightly in the fourth quarter.

Biggest contributors to the business increase are pump and compressor manufacturers with an expected gain of 45% over 1959, and office machinery builders with a forecast of a 25% increase.

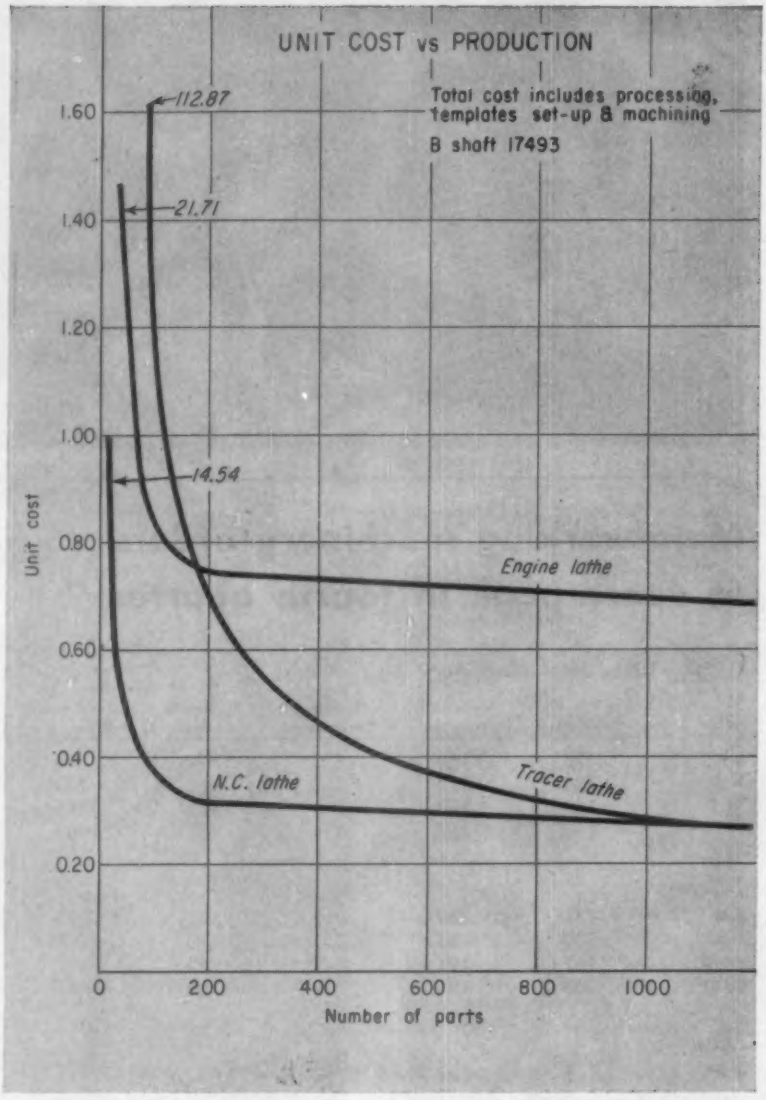
The current forecast provides the first clue to the level of new machinery orders for early 1961. New machinery business in the first quarter of next year is now expected to be at the same level as in the first quarter of 1959 and the first quarter of 1960.

Metalworking machinery orders in the first quarter of 1961, however, should exceed those in similar periods of 1959 and 1960, but will be considerably lower than those of the peak period, the fourth quarter of 1960.

The case for short-run turning . . .

How fast do tape controls pay off?

For the many shops dealing in small job lots of parts, turning operations have been limited to a choice between manual control or time - consuming templet making and setup. Numerical control unfolds new opportunities to those shops where production quantities don't warrant expensive tooling or automatic special-purpose machine tools.



Low unit product costs usually are best obtained on special single-purpose machines, machines which provide high production rates for non-changing products. However, most shops don't have this advantage. They must turn out varieties of parts on a job-lot basis. Only standard machine tools permit the flexibility that is the key to their survival.

For high production rates on special machines, mechanical devices and special tooling can supply control, plus high operating speeds, for desired accuracy. Until recently, general-purpose machine tools were limited to manual (operator) control and productivity was limited by the ceiling of human skill and endurance.

Jigs, fixtures, templets, and similar tooling can extend these general-purpose machine-tool capabilities, but only to the extent that their cost, plus setup cost, is not an excessive burden on unit part cost. Small lots, therefore, frequently make the cost of special tooling prohibitive.

Numerical control offers a long-sought-after answer to the problem of securing high production rates for small lots on general-purpose equipment. It is a boon to the man responsible for small-lot production. With a numerically programmed cycle, cutting action is totally controlled, a certain amount of supervision is inherent in the program, and cycle errors are minimized so that each part of a lot is identical in size and contour. Responsibility for control of accuracy and production rate is taken away from the human operator and placed in the machine director.

In theory, numerical control will not cause a machine tool to operate any faster than it can be operated by a person. Nevertheless, in practice numerically controlled machines are proving to be three or more times as productive as equivalent manually operated equipment. The numerical director is not bothered by fatigue, neither does it worry about its performance to the extent of constant rechecking or easing off on speeds and feeds. Once the program is verified, the machine cuts without interruption.

A "programmed cycle" means that all of the operations are performed according to a planned analysis of the job requirements. A study of the job is made in advance of the machine setup. Coordinate dimensions, read directly from the drawing, or from a manuscript based on the drawing, and all other machine

functions, including speeds and feeds, are included in the program.

Jigs, fixtures, templets, gage blocks, and similar devices on manually operated machines establish a relationship between the cutting tool and the work that results in the desired shape. With numerical control, these devices are eliminated, or at least minimized, because the necessary relationship is established by the machine director through the machine slides and drives. The saving in tooling, tool preparation time, and setup is an extremely important benefit of numerical control.

Two basic types of control

Depending upon the kind of work to be done, there are two basic types of numerical control—positioning and contouring.

Positioning controls, the simpler of the two, are designed to locate a point on the surface from a previously established reference point—and sometimes to penetrate the surface to a desired depth at a required point. In positioning, the machine slides can move independently of each other until they locate the desired point and stop. Positioning is used for drilling, boring, punching, spot welding, etc.

Contouring controls are more complex because they create a shape or form, rather than locate a point. These systems produce a two-dimensional line on a flat templet, or create a full three-dimensional forging die. For contouring, the machine slides must move in constant, exact relationship to each other—and so must be coordinated.

The need for coordination

This need for coordination increases the sophistication of the equipment and the programming. It also replaces a higher order of expensive tooling and time-consuming setup. In some instances, numerical contouring has produced shapes never before obtainable except by approximation. Contouring systems are used on millers, profilers, flame-cutting machines, contour lathes, etc.

Every numerical-control system, no matter how simple or complex, must receive information in a form its director can understand. Thus, it is necessary to encode the data on a transmission media (such as perforated cards or tape) or magnetic tape. Recently, one-inch-wide, eight-channel perforated paper tape was adopted by the Electronic Industries Association as a standard. It is encoded and perforated on a data-processing machine, such as the Flexowriter.

Programming and tape preparation time are functions of the complexity of the part to be machined. Very simple parts can be programmed and on tape in an hour or so. As part complexity increases, programming time increases from perhaps several hours to several days. For extremely complex contours, computers may increase efficiency. It is important to realize, however, that many parts can be programmed on tape without the need for a computer. And because part complexity affects programming and tape-preparation time, this would entail more-complicated and time-consuming tooling and setup.

Programmers are generally selected from among outstanding manufacturing engineers or experienced machinists in the user's own shop. Tape preparation is accomplished by an experienced typist, working from the program manuscript. Training programs for programming and tape preparation are commonly provided by the equipment supplier, and take from a couple of days to several weeks.

NC in the average shop

How does numerical control fit into the average metalworking shop? Monarch Machine Tool Co, Sydney, Ohio, answers this question with the following analysis of the functions of a numerically controlled lathe.

Controlled Process—With numerical control, machine speeds and feeds are automatically controlled, resulting in a fixed cycle and constant rate on the job. On a manually operated lathe, the operator may increase or decrease the cutting speeds and operate at some lower level of efficiency. Such shop level changes are often costly because of increased tool costs, higher maintenance costs, and shorter machine life.

Supervision — Full efficiency and performance capabilities in a machine tool are not easily obtained without a great deal of supervision on the production floor. Because numerical control provides uniform part quality through coded data, less inspection is required and higher production rates can be achieved. Size variation between lots is reduced and operators can be shifted as machine work loads vary.

Reduced Lead Time—Through the elimination of templets, special gages, and fixtures, manufacturing lead time often can be reduced on the numerically controlled lathe. Time required for tool-room work is eliminated and, with standard tools in the turret, secondary operations such as grooving, facing, forming, etc., are accomplished within the one setup. This saving permits a reduction in lead time in producing parts for development programs and prototypes. Components are produced as required, with savings as high as 300% as a result of eliminating special fixtures and templets.

Flexibility—The ability to quickly change over from one part to another on a tape-controlled lathe (less than 0.080 min.) makes it a versatile machine for small-lot production. Automatic machining is available to the small metalworking shop and the low-production plants through numerically controlled turning equipment. Control of the lathe is directed via an eight-track perforated tape, prepared directly from the engineering drawing. Indirect labor is reduced and excessive "down time" for setup on a new part is eliminated. With the "Pathfinder" control, step-turning, boring, contour-turning, facing, and forming can be performed on the same part, or in individual setups. Numerically controlled lathes are not limited to any one field of manufacturing, or to any special field of turning. The control has wide application because of its flexibility and high accuracy.

Tooling—Standard tooling can be used to advantage on numerically controlled lathes. Complicated form tools are replaced by a single profile tool controlled by programmed data. Throwaway carbide tools replace brazed tools of special geometry. Control of cutting speeds and feeds permits the efficient use of carbide under full-load conditions. Cutting action is improved. Often harder grades of carbide can be used at increased cutting speeds because of closer control over cutting conditions. Tool-life is increased from 40 to 60% as a result of the control over surface speed.

In addition, gages and fixtures are simplified and in many cases eliminated. Built-in "inspection" is provided by the control system.

Profile Turning—The "Pathfinder" control is a continuous-path system which produces generated contours by programming a definite number of discrete positions. Motions of the lathe cross-slide and the carriage occur simultaneously, to produce a smooth surface on the work. Tem-

plets are replaced by the punched tape, hence preparation and set-up time are lower. Part duplication is consistently accurate compared to hand operations.

The continuous-path system opens the door to contour parts, as well as complex turning jobs, that previously were unprofitable. Contouring control allows more freedom in design, and the engineer is no longer limited to orthogonal manufacturing processes.

Automatic Operation — Complete automatic cycle control is provided by the X and Y commands and auxiliary functions programmed on the punched tape. The number of cuts, the spindle speed, feed rate, and traverse are all programmed along with the X and Y motions of the tool. Each tool in the turret is indexed into position at the proper time within the cycle as an auxiliary function.

Spindle speeds are preselected over a wide range through tape commands. This control provides the correct cutting speed throughout the turning cycle, and permits maximum use of the available horsepower.

Feed rate over-ride is provided to compensate for material and tool variations so that the chip may be held constant. A zero-shift permits size correction on finish cuts where tool wear and work-spring occur. Jog control is provided for setup and coolant is turned off and on automatically. There is no need for further attendance once the operator has pressed the "start" cycle button.

Cutting machining costs

Machining Costs—Higher production rates, shorter manufacturing cycles, and less downtime are a few of the benefits of numerically controlled machines. On the average shaft job, the numerically controlled lathe saves up to 75% of the actual machining cost as compared with a standard engine lathe.

Savings on indirect costs are even more significant. For instance, a 2⅛-in.-dia B-shaft required 111.8 hr to make the templets for both ends (including layout and paper work). Programming and tape preparation time for this part turned under numerical control was only 1.4 hr. Tape controlled machines are costly, but they are clearly justified by the significant savings in machining time over manually controlled lathes. The following example is typical. In this case, a 56% savings in shop hours was realized in machining a production order of 30 parts (see table).

Part 10685 Shaft
Material A151-4145 Bar Stock

Operation	N.C. Lathe	Engine Lathe
Setup right end	4.00*	34.0
Setup left end	0.80	16.3
Turn right end	0.81	1.38
Turn left end	0.81	1.01
Machining Time (50 parts)	48.60	71.70
Total Time (including setup)	53.40	122.00
Savings in time	56%	

*(Time in minutes)

Most turning work, today, is done on manually operated engine and tool-room lathes. This fact is particularly noticeable in the small metal-working shops. Transfer lines and automatic machine tools are reserved for the large production shops where major tooling programs can be justified by the quantity of parts required.

Numerically controlled lathes cater to the area of low-production, to provide automatic machining cycles for job-lot quantities. They give to the small shop, the development shop, the job-contract shop, and the production shop the necessary control to profitably set up a variety of low-volume jobs.

The unit cost per part for turning a 2½-in. dia. x 10-in. long shaft is given in the accompanying chart. Cost figures are given for a manually-operated engine lathe, a tracer-controlled high-production lathe, and a numerically-controlled lathe. The cost for one part (assuming that only one shaft was required and the job would never repeat) would be $112.87 on the tracer lathe, $21.71 on the engine lathe, and $14.54 on the numerically-controlled lathe. On a more complex part, such as a missile nozzle, the programming time would be longer and the cost (for one part) on the numerically-controlled lathe would likely exceed the cost on the engine lathe.

As the production requirements increase the numerically-controlled lathe shows outstanding savings. For a run of 50 shafts the unit cost per part is $0.54 on the numerically-controlled lathe compared to $1.28 on the manually-operated engine lathe.

When a large volume of parts is required, the tracer-controlled lathe proves to be more economical because of its lower initial investment, and faster cycle. Templet cost for this shaft is written-off at 1000 parts.

On the numerically-controlled lathe, the indirect cost of programming and preparing the tape is written-off at 200 shafts and the unit cost levels out. Further cost reduction then becomes a function of improved cutting tools and the selection of a more machinable material.

It should be pointed out that the machine plays an important part in the performance of any control system. Response of the control must be such that the machining capacity of the lathe is not limited; in turn, the accuracy of the lathe must be such that the full accuracy of the control is realized. Monarch engineers believe that a successful combination comes only when the machine and control have been properly matched by the machine-tool builder to the specific requirements of the job. The "Pathfinder" control was developed, with this in mind, for application to Monarch lathes.

Is machining of exotic alloys predictable?

The National Science Foundation is about to spend $37,000 to test a theory—that machinability of exotic alloys can be determined from their physical properties.

NSF is paying the freight for a three-year research program to be conducted by Associate Professor Joseph Datsko of the University of Michigan. If successful, the study could result in new uses for literally hundreds of new metals and materials, uses which have thus far been limited by difficulty of machining these new, exotic materials.

Professor Datsko will look into mechanical, thermal, and metallurgical properties of high-temperature-resistant materials such as titanium, ferrous compounds, nonferrous metals and plastics—in an effort to predict the machinability of the materials without resorting to empirical machining tests.

Said Professor Datsko, "Traditional machining tests are becoming much too expensive." Sample: the millions spent on titanium tests.

Resistance soldering tools weigh only 5 ounces (contrasted with 21 ounces for the soldering irons they replace), are easy to manipulate, use 40% less solder than regular tools, and cut time per connection as much as 5%

Resistance tools cut soldering time 75%

By Robert Heelan, product engineer, Hawthorne Works, Western Electric Co

With 300 or more connections to be soldered on a single assembly, in this case a crossbar switch, a few seconds saved per connection add up to a sizeable cost reduction in a year's time. That is just what has happened at Western Electric's Hawthorne Works, where time per connection has been cut as much as 75% by substituting resistance tools for conventional soldering irons.

The new resistance tools have as their heating elements ⅛-in.-diameter, 4-in.-long carbon rod electrodes in cork-insulated collet holders. The position of the rod in the holder is easily adjusted to extend the tip when portions break off because of heat or pressure.

Computer controls voltage

Power for soldering is provided by a 115-volt stepdown transformer equipped with a selector switch, so that secondary output voltages may be set between 2 and 8 volts. Exact voltage for heat to match operator speed is obtained by plugging the transformer into a Variac (simple computer), which provides a primary voltage range from 0 to 115 volts. In this way, shock hazard is eliminated.

When the carbon electrode is applied to the work (which is grounded), a low-voltage current passes through the parts, which are rapidly heated to melt the solder, thus eliminating "cold solders." Normally, resistance soldering operations require only 4 to 6 volts, so there is no danger of shock.

Switch springs and the wires to which they are soldered are pretinned to insure sound joints and to speed up operations. Resin-core 30% tin—70% lead solder wire 0.070 in. OD is used.

Under the old soldering setup, two 21-ounce irons were needed for each work station—so that one could be heating while the other was in use. With the new resistance tool setup, heating is instantaneous, and only one 5-ounce tool is needed per soldering station.

Under the old method, solder was melted on the tip of the iron, causing dripping and splashing and consequent waste. Only 40% as much solder is now needed for each connection, because the solder wire is melted by the heated parts, not the tool. Heating of joints is faster, too, because the heat is now concentrated at the exact area to be soldered.

The carbon tips of the new tools require no redressing and need to be adjusted only occasionally. The formed iron tips of the soldering irons, on the other hand, required frequent redressing.

Weighing apprenticeship in the balance

East hears apprentices themselves urge no cutback in 8000-hour courses

In the last few years, there has been a movement afoot across the country to cut back the traditional 8000-hour metalworking apprenticeship courses by giving the apprentice credit for previous, even related, experience, for academic training, and for exceptional aptitude in the shop.

Apprentices air their views

Trouble is, the apprentices themselves don't want the 8000-hour course shortened, even though it would mean that they would reach journeyman status and journeyman pay sooner.

This was forcibly brought out by a panel of three outstanding apprentices at a meeting late last month of the Eastern Seaboard Apprentice Training Directors' Association at Wentworth-by-the-Sea, N H.

They agreed unanimously that even an 8000-hour, four-year apprentice course is scarcely sufficient to make a skilled machinist, tool and diemaker, or draftsman. They agreed, too, that they don't want incentives for first class performance, feeling that it is up to the man himself to do his best on a job—that he is the best judge of his own work—rather than an outsider who might award or withhold incentives unjustly at times.

Apprentice gripes

Not that the three apprentices are insensitive to money—there were some veiled remarks about rates paid to helpers, machine operators, and other semi-skilled or unskilled workers, as compared to those paid apprentices. The apprentices also derided the practice of calling a graduate a journeyman, but making him wait a year before paying him the beginning rate for a journeyman.

The appearance of the three apprentices before 50-or-so training directors, labor leaders, and government officials was a highlight of the three-day Conference. Each of the three men is somewhere between 26 and 28 years old, married, and a father. All of them spoke well, joined in the discussion vigorously, even threw out a few "shockers."

Here is one:

Richard Tambling, who won honors in the recent Connecticut Valley Apprentice Contest, failed an aptitude test for the trade. Later, after serving with the Armed Forces, he received an apprenticeship at Arrow, Hart & Hegemann, a company that does not use an aptitude test. Today, Tambling is a top apprentice who believes that attitude and motivation are more important than the results of aptitude tests, "If journeymen in a shop accept an apprentice and try to help him, it's as good a sign as any that a man will get along."

The helping hand

Another of the apprentices, Charles W Abbott, machinist apprentice at Portsmouth Navy Yard, likes the practice of older apprentices helping younger ones. "Serving as a teacher in a limited way helps the older apprentice," he said.

Albert Lancisi, mechanical draftsman apprentice at Draper Corp, agreed that motivation is important, particularly nowadays when the apprentice is likely to be a married veteran. He believes that an apprentice soon earns his pay, and perhaps a bit more. He does object, however, to the hiring of unskilled helpers at rates above those now being paid apprentices.

Shortening in-shop training

A program that might shorten apprentice in-shop training has been started at Maine Vocational Technical Institute, South Portland. Two years of shop and academic training are given, followed by two years in industry. If given at the junior college level, applicants can be charged tuition— after they have been carefully screened for motivation.

. . . While the West admits its training program is a "notable failure"

Doing some soul searching, labor and management representatives of the machinist and tool and die trades recently characterized California's apprenticeship program as "not off the ground" and a "notable failure."

The facts: Unless more apprentices go into training now, there will soon be no journeymen to serve the state's fast-growing population, which now stands at 16 million, should reach 21.7 million by 1970.

In California today there are only 542 active machinist apprentices, and 236 tool and die apprentices. The national picture is even more critical—there are only 10,000 machinist and tool and die apprentices, compared with 106,000 for the building trades alone.

These facts were brought out in a California state conference on apprenticeship May 20 in San Francisco. Management representatives were pretty glum about the outlook. Said one, "We're so short of machinists in the San Francisco area, my plant is losing work."

Management apathy scored

Actually, both management and labor people laid the blame for training failures to apathy on the part of management. One speaker suggested that employers be given either federal or state aid to help finance apprentice training. This aid could be in the form of tax credits, surplus equipment from the government, or equipment loans at low rates of interest. Also recommended: grants-in-aid for students interested in learning crafts.

Another suggestion (by a labor leader): "The only way we can train enough apprentices is to put in the contract that any shop that can meet Joint Apprenticeship Committee standards must train an apprentice. If the shop has the basic machine tools of our trade, it can do a training job. Good apprentices come out of small shops."

Rotating apprentices?

Another labor man disagreed, offering this alternative: At least one apprentice should be trained per 10 journeymen in a given area. To meet this expense, all area employers would be required to pay a per capita tax. Apprentices would be indentured to the local JAC, rather than to any one shop, and would be placed in shops on a rotating basis. JAC would supervise training and pay the apprentice.

It was also suggested that any company getting federal contracts must train apprentices.

1000 connecting rods are turned out in an hour as . . .

Chain broaching takes over at Buick

Nearly 1000 connecting rods are being turned out per hour on two continuous horizontal broaching machines at Buick's Flint, Mich, engine plant. If necessary, 1200 can be broached in an hour.

By replacing vertical twin-ram broaches with Foote-Burt Model 15L broaches, Buick has achieved far easier operation, longer tool life, and quicker tool changes, as well as faster output.

For example, the operator has only to drop the blank SAE 1020 forging into the fixture, and machines do the rest: centering the parts, positioning them for cleanup, carrying them through the cutting cycle, and depositing them in the parts hopper after broaching.

Throughout these operations, the connecting rods are held well within Buick's tolerances of 0.005 in. for length and 0.002 in. for taper. These tolerances are especially important because operators depend on them when positioning the rods on fixtures for subsequent machining operations. A slight error in broaching could snowball into a big one in the finished part, or make it necessary for slow, expensive corrections later.

Operator inserts blank rods into one of 22 fixtures on Foote-Burt continuous horizontal broach. From here on out, operation is fully automatic

22 fixtures on endless chain

An endless chain containing 22 fixtures moves from the operator station to a discharge conveyor at the other end, like a conveyor belt. The operator simply places a blank connecting rod on each fixture as it passes—the rest is automatic. Once the part is in the fixture, the machine self centers it and locks it into position, automatically locating the piston hole to position the rod for correct length. Then the fixture carries the part across the cutting tool, and delivers it to the discharge conveyor at the other end, fully broached.

Up to 20 cu in. of mild steel can be cut per minute—or 30 cu in./min of cast iron. Maximum broach length is 100 inches.

An automatic plugging switch senses if a rod is improperly loaded, plugs the motor for instantaneous stop before the machine or tool can be damaged. Shear pins in the drive system offer further protection.

Before broaching, the connecting rod blank sides are first ground on opposed disk grinders—some stepped between piston pin and crankshaft, and others flat, depending upon the engine model. The rods are then drilled and reamed for piston pin holes, and carried by hopper to the broaches.

Only one operator is needed at each of the two machines to broach the joint faces and bore of Buick's entire connecting rod output. Formerly, with 66-in. vertical twin-ram broaches, the operator loaded two rods at a time in vertical fixtures at each ram, positioning them and locating pins for accurate broaching. The fixture would then index the parts into the broach, and the downstroke would do the cutting. On the upstroke, he would remove the finished parts, put two on the other ram (opposite stroke), and push two buttons to actuate the cycle. Output was half that of the new method, tools lasted only a fraction as long as they do today, and tool changing took four times as long.

110-inch broaching tool

Heart of the Foote-Burt broach is its 110-in.-long broaching tool, which is made up of a number of sections and is slightly tapered so that it gets larger as the connecting rod progresses toward the end of the tool.

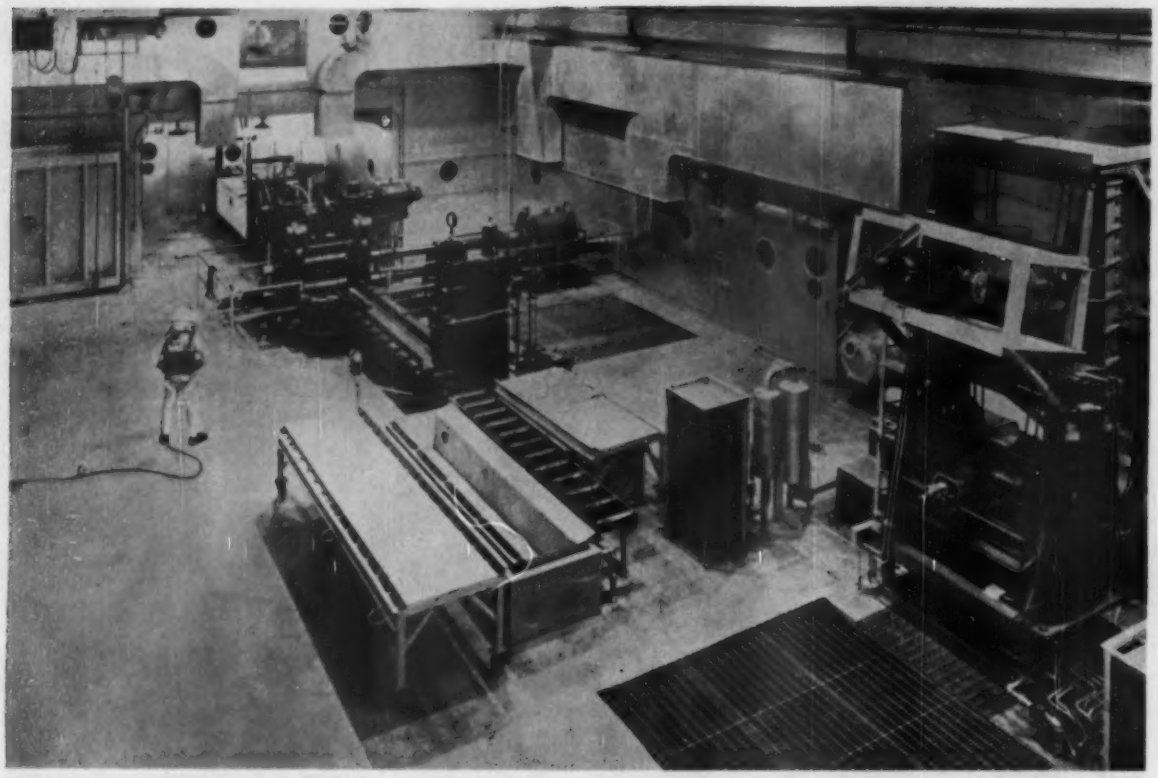
Buick's tool grinders preset the broaches from master charts in the toolroom, supplied by the manufacturers. As tools need regrinding or replacement, they are taken from the machine as a complete unit, rather than by section. (Because there is only one cutter holder to change, the job is simple.)

As each rod enters the machine, it contacts first the flat cutters that broach the joint faces. Then it advances to half-round cutters, which broach the bore (arranged small ones first, and progressively becoming larger until the final smooth cut at the end). The cutters remove 3/16 in. of metal from each surface.

As the half-round tool sections wear, they are moved progressively toward the small end. New tool sections start out at the large end, where the final smooth cuts are made in the bore. As they get smaller, they move toward the beginning end of the tool, where the first rough cuts are made.

Such rotation increases useful tool life several times over, because tool sections needn't be discarded with wear except when they have reached the first (smallest) position. Flat tools for broaching the joint faces are shimmed to compensate for wear.

Coolant is Vantrol 523 mixed with six parts of water, a richer mixture than that for ordinary broaches—because it also lubricates the fixture chain.



Inert-fabrication facility is a welded-plate structure 42x97 ft and 23 ft high. Equipment includes rolling mill (center) and forging machine and manipulator (at right). Machine tools will be added

Shaping space age metals in argon

Refractory metals (molybdenum, columbium, tantalum, and tungsten) have come up almost from nowhere into metalworking prominence in the last few years—simply because they and their alloys are virtually the only metals that can stand the high temperatures to which hypersonic aircraft and aerospace weapons are subjected.

Unfortunately, these metals and their alloys are tricky things to handle. They are exceptionally hard to machine, and they tend to pick up impurities out of ordinary air. Molybdenum's tendency to oxidize in air, for instance, has been described as "catastrophic."

Obviously, then, such metals cannot be machined with any consistent degree of success unless the job is done in an atmosphere purer than that of air.

That is where InFab comes in. It is Universal-Cyclops' Steel Corp's name for its new Bridgeville, Pa, facility, where refractory metals are now being forged and rolled at temperatures up to 4500 F in a protective atmosphere of argon gas.

InFab is a welded steel enclosure 42 ft wide, 97 ft long, and 23 ft high, housing an Impactor, a rolling mill, furnaces, and a 10-ton crane—all of them remotely controlled. In effect, InFab is a huge envelope filled with inert gas.

Refractory metals (formed from metal powders by compaction and sintering into electrodes) are melted into ingots in a consumable-electrode, vacuum-arc furnace just outside the facility. Ingots can be up to 70 inches long, weigh up to 3000 lb.

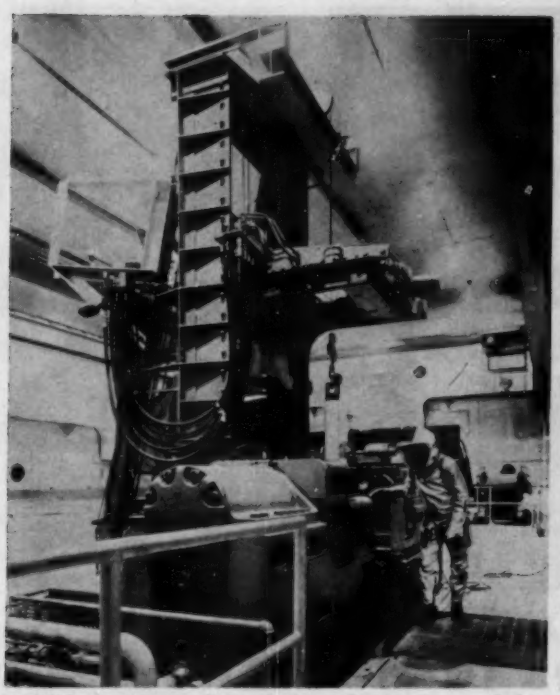
New forging, rolling methods

From here on out, the InFab facility with its 99.9995%-pure argon atmosphere departs radically from conventional forging and rolling processes. The horizontal Impactor breaks the ingots down into billets or sheet bar at temperatures up to 4500 F in the protective argon atmosphere. The remotely controlled, fully automatic Impactor hits the ingot on two sides with a force of 15,000 ft lb, causing deformation to take place equally on both sides.

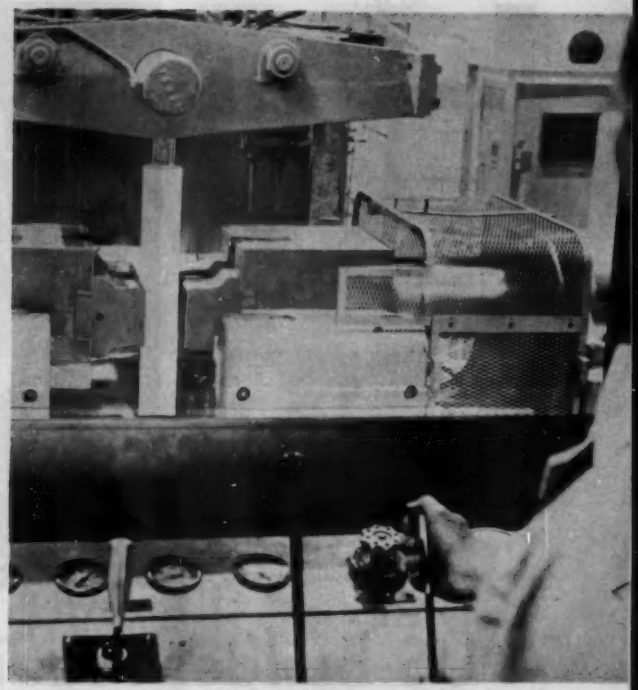
Ingots are then heated in induction furnaces, located immediately under the forging zone—so close that ingots can be transferred into forging position within 2 seconds, thus keeping heat loss to a minimum.

If further processing is required the billets (4-in. round-cornered squares) and the sheet bars (2 x 10-in. cross section) are transferred to the rolling mill area, where they are heated in a graphite-lined indirect induction furnace at the end of the rolling mill table. Metal is prevented from reacting with the graphite by a molybdenum furnace liner.

The mill rolls the metals into bar and sheet at temperatures up to 4000 F (steel is usually rolled at temperatures to 2300 F in conventional rolling mills), with the entire operation controlled from a console out-



Molybdenum ingot is lowered into induction furnace below Impactor for heating to 4500 F



Operator at console outside InFab room watches through window as ingot is automatically forged

side the facility. Roll tables, alligator shear, bar turner, and pinch rolls permit fully automatic operation.

Similar to a miniature blooming mill, InFab's two-high 16 x 36-in. mill has flat and grooved rolls, can produce bars as small as ½-in. diameter, and sheet up to 15 in. wide and 96 in. long. Sheet gages of 0.020 in. are obtainable through pack-rolling.

At the moment, practically all operations are controlled from consoles outside the facility, through picture windows that shield out ultra-violet rays.

But Universal-Cyclops plans to conduct experiments on hot machining and welding of refractory metals soon. This will mean that personnel will have to work inside the argon-protected facility.

To do the job, technicians will dress in "space suits"—four-layer, gas-tight suits, with an outer garment that shields against heat and ultra-violet radiations. Each man will carry an air supply and a cooling unit on his back, which are connected to outlets inside the facility.

Everything — men, materials, equipment—moves in and out of InFab through one of three locks. The argon is maintained at a pressure just above that of the surrounding atmosphere, so that it rushes out if a lock is opened, rather than air rushing in.

Work coming in to facility is placed in tube-shaped materials lock. Air is evacuated and replaced with argon before technician opens the lock to remove work

Inside the facility, the argon gas is continuously cooled (because of the high temperature of the metals being fabricated) and recirculated, so that an average temperature of 80 to 100 F is maintained.

With InFab, Universal-Cyclops hopes one day to produce vastly superior refractory metals and alloys at the same cost as similar (but less pure) metals now commercially available. At the same time, it hopes to contribute materially to the technology of forging and hot machining of refractory metals.

A new Research Center . . . and five new machine tool developments like this tape-controlled turret lathe steal the spotlight as . . .

A US builder readies for the Show

Shape of things to come in the U S machine tool industry—in the immediate future and over perhaps the next decade—was afforded visitors at Warner & Swasey's recent twin unveiling of five new machine tools that will be shown at the Machine Tool Exposition in September, and of its newly completed 40,000-sq-ft Research Center, now in operation at Solon, Ohio.

Bearing out reports that U S builders will concentrate on numerical control as never before at the forthcoming Exposition, three of Warner & Swasey's five new machines will be tape controlled: The other two are a miniaturized single-spindle chucking automatic, and a micro-cut turret lathe.

Warner & Swasey's new Research Center, now fully staffed and operating, has this motto on the wall of the lobby, "Building for the Future." The cornerstones: machine tool development, design and research into earthmoving equipment and textile machinery.

The ultra-modern, one-story Research Center will bring all company R & D activities under one roof. Separate departments include machine design, systems design, electronic controls, servo development, instruments, metal cutting and metallurgical laboratories, plus a shop capable of producing prototypes of all new product designs. About one-third of the Center's floor space is given over to a high bay general test section, where full-scale prototypes and models can be tested.

Five new machines

Five new machine tools, all of which will be shown in Chicago at the Machine Tool Exposition in September, shared honors with the Research Center in an all-day open house June 1. They are:

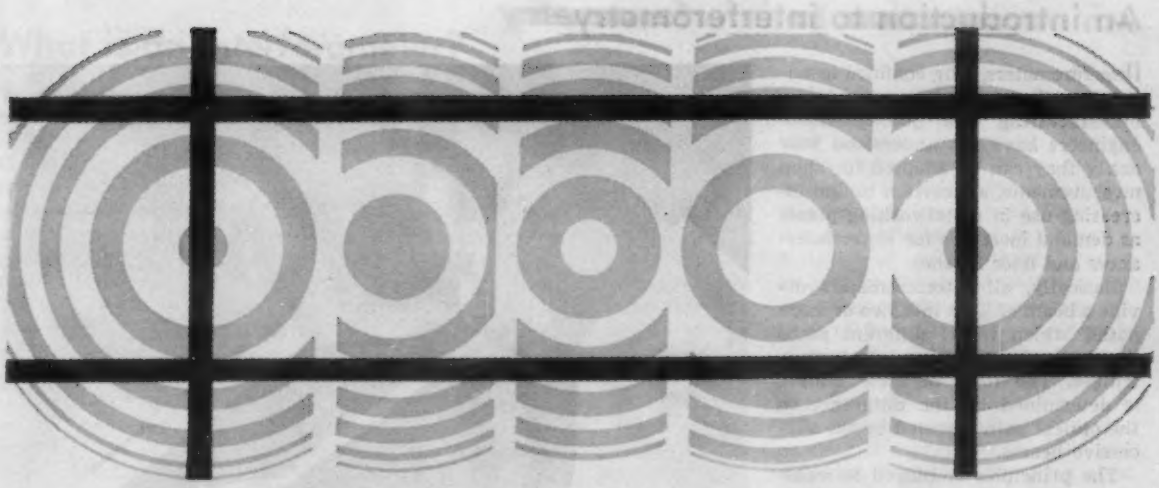
• The "Servofeed," a 25-inch-swing numerically controlled turret lathe (photo) equipped with an electronic "memory" system designed to store and recall operating commands for any machining setup. The electrically controlled machine can store up to 96 consecutive commands for changing machine speed, and starting rapid traverse. It requires no tape or outside programming. Operator merely pushes a button at the end of an acceptable cut during setup, and all commands that went into the successful cut are stored in the machine's memory. The machine does the rest—repeating each operation automatically. There is also tape path-control for contouring.

• W & S's 1AC single-spindle chucking automatic now comes with an optional numerical tape control for such operating functions as speed and feed change, cross slide movements, and length of cut. Entire automatic machining cycle can be preplanned on tape, except for selection of high-low speed range, and installation of feed gears by the operator.

• The O-AC is a new miniaturized single-spindle chucking automatic designed "to bring the advantages of automatic production to small lot producers of precision components." Machine can work a 3-in.-dia by 3-in.-long piece, can quickly be changed over from job to job. Machine has 16 spindle speeds in four ranges of four speeds each. Spindle speed selection, front and rear cross slide and turret feed selection are fully automatic.

• W & S's cross-sliding turret 4-A lathe now comes equipped with a new two-axis numerical control contour system. With it, the 4-A can handle complex contouring work up to the full dimensional capabilities of the lathe — and tool interference and limited slide travel are eliminated. The machine can contour either irregularly shaped surfaces or straight line or taper cuts of any angle.

• New No. 2 Micro-Cut turret lathe is designed to handle highly critical machining of small-to-medium-sized precision parts. It is especially suited to machining jobs involving miniature components of all kinds. It is in effect, the W & S people say, a rugged turret lathe and at the same time a precision instrument lathe.



An introduction to INTERFEROMETRY

Thomas J O'Donnell, author of this report, is shown checking a Michelson parallel interferometer. Mr O'Donnell, last surviving member of the group that worked with Prof A A Michelson on his famous velocity-of-light tests during the 1920s, built one of his first interferometers aboard the USS Arkansas in 1918 to check straightness of machine ways and to align surfaces square and parallel

By Thomas J O'Donnell
superintendent
Physical Sciences Development Shops
The University of Chicago

In industry's search for better inspection devices, the interferometer is going to take on a major role. Most interferometers are built of mirrors, lenses, auto-collimators, and a variety of other items—all of which you may be tempted to dismiss as unfitted for shop use. But you'd be wrong. Many are quite simple, both to build and to use. Remember, the optical flat, when used under monochromatic light, is an interferometer. We'll show you, in this report, how such instruments can be used in the shop to measure and compare lengths, angles, parallelism, and surface condition

American Machinist / Metalworking Manufacturing

Special Report No. 490 • June 13, 1960

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An introduction to interferometry

Interferometers, long confined to scientific laboratories because most manufacturing and quality-control engineers have not understood how easily they can be adapted for shop measurements, are certain to find increasing use in metalworking plants as demand increases for closer tolerances and finer finishes.

Basically, all interferometers divide a beam of light into two or more paths, which travel different paths then recombine to form interference fringes. The form of these fringes is determined by the difference in the optical path traveled by the successive beams.

The principles employed to measure a part interferometrically differ accordingly as the dimension is a small fraction of a wavelength, a few wavelengths, or several thousand.

In a toolroom, accurate measurement of length, tests of parallelism, and measurement of angle can be reduced to comparison of lengths which are very nearly equal. For such work the interferometer is unsurpassed, for it measures the differences in units which are constant, wavelengths of monochromatic light.

One type of interferometer, the glass or quartz optical flat used under a source of monochromatic light (Fig. 1), already is used under open shop conditions throughout the metalworking industry to check ground and lapped parts, and under gage-room conditions to compare shop gage blocks with precision master blocks.

A review of the interferometers described in this report will show that several other types of interferometers, if used properly, also can help solve precision production problems.

1. Newton's rings of lightwave interference are used to compare gage blocks or workpieces with master blocks, and to check surface quality, when viewed under an optical flat illuminated by monochromatic light. Helium-filled lamps which emit light with a wavelength of approximately 23.1 microinches (0.000,023,1 in.) generally are used with optical flats *(Photo courtesy Crane Packing Co.)*

Varied applications

Precision gage block and index table manufacturers are already using modifications of Brewster, Fizeau, Michelson, and other types of interferometers to inspect and calibrate their products, rather than send them to the overworked calibration rooms of the National Bureau of Standards.

At The University of Chicago, we have for a number of years made wide use of various interferometers, most of them designed and made in our own shops, to help check and calibrate precision instruments required by scientists in University laboratories. Some were used on the Manhattan Project, others have played a part in the University's space research programs.

With properly designed and constructed interferometers, it is possible to position and align surfaces accurately, and to measure and calibrate to very close limits more precisely and more easily than with precision gage blocks, indicators, auto-collimators, and other conventional dimension and position-checking devices.

In fact, under normal shop precision inspection conditions—involving temperature and humidity controls in air-cleaned rooms—it is possible with an interferometer to check dimensions of precision parts to within a few millionths of an inch, and angles to within 0.10 to 0.05 sec of arc or closer, and do it inexpensively.

This does not mean that all interferometers must be used inside master gage and precision inspection rooms. Many are used today in normal shop surroundings with consistent results. Remember, the optical flat under a monochromatic light is an interferometer. Location of the instrument, and the need for controlling temperature, humidity, and other ambient conditions, depend upon how fine a tolerance must be held.

Inspection operations difficult to perform with other types of checking devices are often relatively easy with an interferometer. You can easily check the accuracy of precision screws, for example, with a specially designed modification of the Michelson parallel interferometer. In one setup it shows both lead errors and drunkenness. Accuracy of either lineal or circular indexing can also be checked with relatively simple setups. Interferometers were built into both of Michelson's ruling engines for cutting precision diffraction gratings.

Most interferometers are designed to check relatively short linear dimensions. However, it has been reported that some 30 years ago, in Finland, Vaesale measured distances some 100 meters long by interference methods, and that Watanabe and Masaki of Japan in 1927 calibrated a 5-meter survey base with a Fabry-Perot interferometer in terms of the red line of cadmium.

What is an interferometer?

Interferometers are optical instruments that use the phenomenon of light wave interference to compare the displacement of wave fronts of two or more pencils of light which, after having been emitted from the same source and separated optically, are directed along different paths and then recombined for observation. Their design is based upon the *principle of superposition* first postulated by Huygens in 1678, more clearly stated by Thomas Young in 1802.

Young showed that the instantaneous resultant of displacement of two separate light beams acting together is the algebraic sum of the two separate displacements.

Use of the term *interference* to describe this phenomena probably is incorrect, since the principle of superposition implies the independence of the individual component beams from the resulting displacement. This is in line with the findings of Ebert, who showed that light beams, no matter how intense, do not affect other light beams whose paths they cross.

Generally, optical arrangements which produce light wave interference are cross classified (a) by the kind of wave division—as wave front or amplitude methods, and (b) by the number of light wave divisions employed—as either two-beam or multi-beam interference.

When two or more pencils of light, which must have originated at a single source so the separate pencils will have identical characteristics, are superpositioned upon each other to interfere and form a fringe pattern, light is either (a) redistributed so the energies of the dark fringe regions are collected and absorbed by the bright fringe regions—this redistribution is seen directly in the field of view and is known as *division - of - wave - front interferometry*, or (b) redistributed in two directions, with complementary patterns of fringe energy being formed in separate fields of view—this is known as *division-of-amplitude interferometry*.

In division-of-amplitude interferometry, the observer usually sees only one fringe pattern at a time. If he wishes to see the missing light energy of the dark fringes, he will have to observe the complementary bright fringes from another position.

Division-of-wave-front interferometry

Division-of-wave-front interferometers divide the wave front of a narrow pencil of light into two or more adjacent fronts, then by reflection or refraction cause them to cross and superposition one with the other at some locality in and out of phase with each other.

If the point of light source is sufficiently small, it is possible to select adjacent wave fronts with similar phases emerging in slightly different directions from the same source. These wave fronts can be further separated optically by mirrors, prisms, and lenses, and then brought together again to create interference patterns.

The larger the area over which the wave front must be coherent (of the same phase), the smaller must be the angle subtended by the point of light emerging from the source. When the aperture opening (pinpoint or narrow slit) at the light source is too wide, interference fringes disappear. A modification of this phenomenon was used by Michelson in his stellar interferometer, developed to measure the angular diameter of stars, and later by Gerhardt in a modified Michelson device designed to measure the diameters of ultra-microscopic particles.

Two-beam interferometers classed as division-of-wave-front instruments include the Fresnel inclined mirrors and biprism, Lloyd's single mirror, the Rayleigh refractometer, and the Billet split lens. Diffraction gratings and echelons are classed as multi-beam division-of-wave-front instruments, though it must be noted that *diffraction* and *interference* usually are considered separate wave character phenomena. The term *diffraction* usually applies to gratings and echelons, and to narrow pencils of light that are bent as they pass obstacles.

Diffraction needs only a small bending of the pencil of light, since wavelengths making up visible light are approximately only one-half micron (0.0004 to 0.0005 mm or 0.000,015,904 to 0.000,019,88 in.) in length.

Because the properties of the light sub-fronts must be very similar, to a degree depending upon the required closeness of the fringe pattern, very intense light sources are required if division-of-wave-front instruments are to compete with division - of - amplitude interferometers for making precise measurements in the toolroom or master gage room. They seldom are found outside the scientific laboratory.

Division-of-amplitude interferometry

Division-of-amplitude interferometers split a pencil or beam of light amplitude-wise into two or more pencils by partial reflection at a 50%-reflecting surface of a plate-glass dividing plate or beam-splitting prism for two-beam interference, or at a greater percentage at each surface for multi-beam interference, as approximately 80% for each of the two surfaces of a parallel plate, or for the two interface surfaces of an etalon. One of the pencils of light is reflected, the other is transmitted through the beam-splitter.

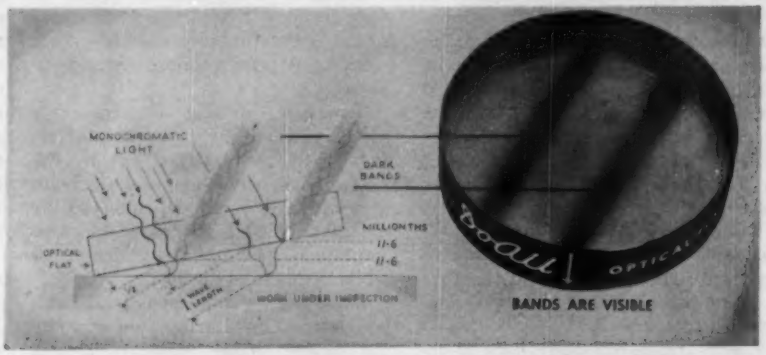
Extended light sources are used for most two-beam division-of-amplitude interferometers. However, in some, like the Twyman interferometers, the source is limited to a point of light for developing uniformly - spaced straight-line fringes where circular fringes of different fineness for different differences in path would otherwise appear. The pencils of light in such setups are simultaneously divided amplitude and wave-front-wise to project an entirely different kind of light wave interference pattern than that developed by true division-of-amplitude interferometers.

In division-of-amplitude interferometers there must be a point-to-point area of correspondence between the wave fronts of the transmitted and the reflected beams where they are superpositioned upon each other. Any irregularities in one beam must be present in the other. If this is accomplished, complexities in the original wave front will not affect the interference pattern.

Two - beam division-of-amplitude-interference setups include the thin

film studies of Robert Boyle in 1657, the circular rings (fringes) first described in his *Micrographia* in 1665 by Robert Hooke and later examined in more detail by Sir Isaac Newton, the interferometers developed by Sir David Brewster in 1817, the thick parallel-plate fringes reported by Haidinger in 1849, Fizeau's collimated-pencil contour fringes of 1862, Mescart and Jamin's rectangular interferometer of 1874, Michelson's right-angle interferometer of 1881, the Twyman and Green combination Fizeau-Michelson interferometer of 1916, and Michelson's rectangular interferometer of 1925, as well as a number of more recent designs.

2. "The poor man's interferometer."— Perfectly finished and distortion-free glass or quartz optical flats clearly show Newton's rings of light wave interference when viewed under monochromatic light. Interference bands shown are identical with those developed in a Michelson interferometer *(Photo courtesy The DoAll Co.)*



3. Rays of monochromatic helium light passing through optical flat above workpiece are, in effect, split in two. One portion is reflected to the eye from the lower surface of the flat, the other passes on to the surface of the workpiece and then is reflected back toward the observer. When reflected portions cross each other, as above, interference produces dark bands wherever the distance between the reflecting surfaces is one-half wavelength (0.000,011,6 in.) or a multiple thereof. Each band is like an elevation line on a contour map *(Photo courtesy The DoAll Co.)*.

Newton's contour fringes of equal thickness

When, in 1665, Robert Hooke produced concentric colored rings between two lenses of large radius of curvature, he found that color depended on the thickness of the air film, and that equal thicknesses across the air wedge between lenses always produced the same color.

These colored, localized fringes were later studied in more detail by Sir Isaac Newton, who found the same effects could be obtained between a spherical and a flat surface. When the difference in curvatures is small, the fringes, now known as Newton's rings and as *contour fringes of equal thickness*, are easily seen by the naked eye.

Newton's rings (Fig. 2) can be regarded as contour map lines of equal elevation (with one fringe for each half-wavelength of the light used, as the light for interference must travel a double distance) of the air wedge between the surfaces. When monochromatic light is used, these fringes give a precise measure of the thickness of the air wedge.

These contour fringes of equal thickness are the basis for precise measurements when glass or quartz optical flats are used under a monochromatic light source. Viewed under a helium lamp, as is common practice today in U S metalworking plants, the interference bands seen between the bottom face of the optical flat and the surface of the work (Fig. 3) indicate differences in height between the flat and work surface of 11.6 microinches (0.000,011,6 in.) or multiples thereof. The number of bands between two selected points, therefore, is a direct measure of the relative differences in their heights; band shape indicates any departure from a flat plane of the surface being inspected.

Brewster's white-light interferometers

Sir David Brewster in 1817 produced white-light fringes by transmission through a parallel-plate interferometer of his design. The reflecting surfaces of these instruments were, in terms of wavelengths of light, great distances apart.

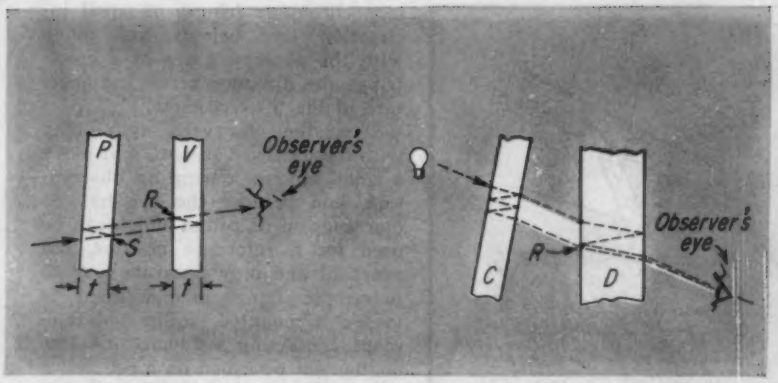
Brewster's arrangement (left, Fig. 4) actually was a double interferometer that consisted of two glass plates P and V of *equal thickness* (t) mounted in series and inclined slightly (1° to 2°) to each other.

A pencil of light passing through plate P (the first interferometer) is divided amplitude-wise into two effective rays at point S on the beam-splitting inner face of P. One of the split rays is reflected back into P and transmitted to point R on the second plate V (the second interferometer) after having been reflected from the rear of P. The second ray is transmitted from S to and through V to its outer face, from where it is reflected back very close to R. At R, the wave front of the second ray is superpositioned on the wave front of the first ray and reflected toward the observer.

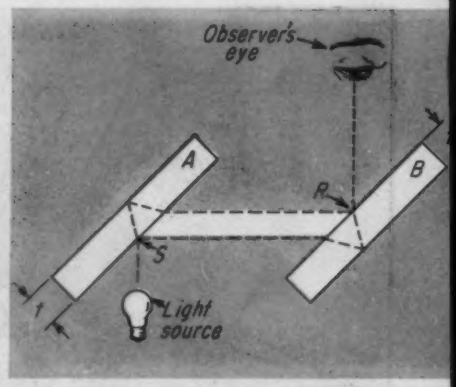
Each ray has, therefore, experienced two transmissions through a plate of equal thickness before reaching the recombining point R.

When the two interferometer plates P and V are of equal thickness, the white-light fringes will be positioned on an axis which bisects the normals of the two plates. This system of fringes is formed parallel with the apex of the air prism between the two plates. They are *fringes of inclined planes*, whereas Haidinger's circular monochromatic fringe systems, which also appear to originate at infinity, are classed as *fringes of equal inclination*.

Brewster white-light fringes devel-



4. Parallel white-light fringes are developed when light rays pass through nearly parallel plates of the Brewster interferometer (left). These colored bands are fringes of equal inclined planes. In the Brewster optical multiplier (right), plates of different thicknesses, one some exact multiple of the other, are employed to provide optical paths of equal length for the two rays



5. Dividing and compensating plates, *A* and *B* respectively, of a Michelson interferometer can easily be set parallel by using reflected light pencils to develop Brewster white-light fringes, then slowly adjusting one mirror until a single wide fringe covers the aperture. Plates must be same thickness

oped by transmission of light through a pair of nearly-parallel glass plates are difficult to see if the background is brightly lighted. Visibility can be improved by using a spot source of light, by shielding the light source with diaphragms, or by revising the optical system to reflect the light rays into the plates.

The Brewster-type optical multiplier (right, Fig. 4) is of the same basic design as his parallel-plate interferometer, except that one plate is thicker than the other by some exact multiplier. If one of the split rays in this instrument experiences two transmissions (one round-trip) through the second, and thicker, plate *D* before reaching the recombining point *R* on its front face, the other ray must travel as many round-trips back and forth between the faces of the thinner plate *C* as plate *D* is thicker than plate *C*, before being transmitted to point *R*.

Gaging applications

In either of these Brewster interferometers, white-light fringes will appear only when the path differences between the two interfering rays varies between zero and a few wavelengths of the light used. This characteristic makes the Brewster principle especially applicable for gaging devices, and for checking the parallel alignment of glass plates in other types of interferometers.

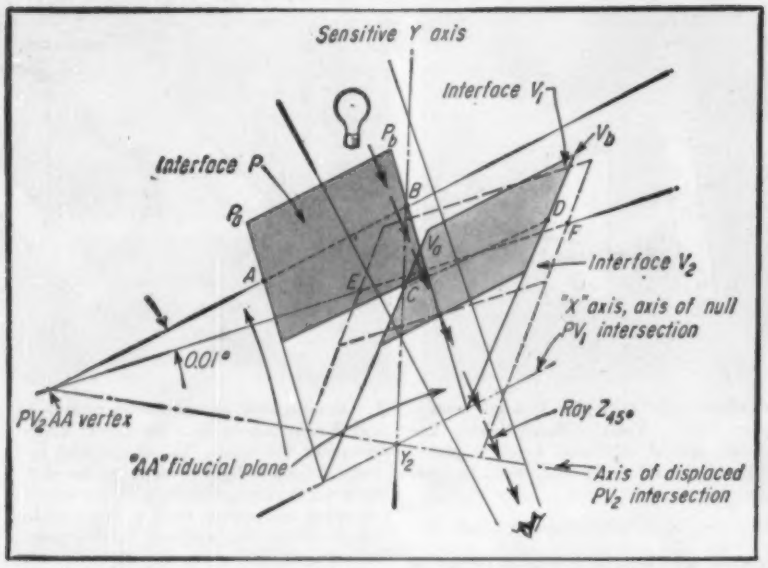
Because in Brewster's interferometer white-light fringes appear to originate at infinity, they move as a group with the observer's eye in a cross-fringewise direction across the exit aperture. Therefore, a fixed telescope with cross hairs must be used to determine the displacement of the central white-light fringe in terms of light interference fringes when a modified Brewster interferometer is used as the measuring unit for gaging device.

The chief criterion of the central white-light Brewster fringe, when it appears to lie at infinity in a direction that bisects the angle between the normals of two sets of Brewster plates (whether air or glass), is that the ratio of the spacing or thickness of the plates is exactly a whole number. This fact was employed advantageously by Fabry and Perot when redetermining the length of the International Meter in numbers of the red cadmium line's wavelength. They constructed a series of parallel Brewster air plates, each having twice the length of the one preceding. The number of wavelengths across the air space of the longest, which measured approximately one meter, was determined in a few hours once the number of wavelengths across the shortest had been measured, by intercomparing the various intermediate Brewster units with the Brewster white-light fringe.

Clear, symmetrical Brewster white-light fringes are projected when the dividing and compensating plates *A* and *B* (Fig. 5) of a Michelson interferometer are aligned approximately parallel with each other, using the reflected light system devised by Jamin. This makes it possible to align the parallel plates of a Michelson interferometer optically after they have been lined up mechanically as closely parallel as possible. When viewed as shown, they are aligned until the Brewster white-light fringes appear clearly. Then, very slowly, they are further adjusted until only one wide fringe is seen. When this occurs the plates are precisely parallel.

In 1922, while experimenting with reflection-type Brewster white-light fringes projected by the dividing and compensating plates of a Michelson interferometer mounted on a diffraction grating ruling engine, I noted a sensitive fringe displacing phenomenon. When the two parallel plates were tilted approximately 2° relative to each other about a horizontal axis to produce a group of narrow, horizontal Brewster white-light fringes, a very slight rotation of the compensator plate about a vertical axis caused the fringe group to move up or down several fringes. Sensitivity of this control increased as thicker parallel plates were used, and as the incident angle of the entering beam of light was increased, up to about 50°. At larger incident angles, sensitivity decreased.

This rotational control of the displacement of two parallel interferometer plates about an axis approximately parallel to a plane bisecting the wedge apex formed by the interfaces of the two plates, and oriented approximately 90° with the axis of the 2° tilt between them, is the position-determining feature of an O'Donnell-Brewster interferometer developed some years before to determine the flatness of surface plates, and later adapted for use with angle-determining and positioning instruments. The precision of these instruments has convinced me that the Brewster principle has many untapped potentials in the gaging field.



6. O'Donnell-Brewster interferometer (simplified) shows interfaces of *P* and *V* plates of the Brewster interferometer in parallel (null orientation) positions, and as displaced by rotation of the *V* plate about the sensitive *Y* axis added by O'Donnell. Location of the displaced PV_2 axis and the fiducial plane *AA* determine slope and position of white-light interference fringes which develop. A basic description of how the instrument works, and what it does, will be found in the text

O'Donnell-Brewster interferometers

The O'Donnell-Brewster flatness-testing, angle-measuring, and null torsional interferometers are, in effect, simple Brewster setups of two nearly parallel optical plates of exactly the same thickness, tilted one to the other—plus the important rotational feature by which angle determinations and null settings are made with considerable precision.

No attempt will be made here to explain in detail the performance of the optical system employed; its analysis is a complex geometrical and optical problem. However, its mechanics are quite simple, easy to understand, and with normal care, quite easy to use.

Basically, the instrument (Fig. 6) consists of the equal-thickness *P* and *V* plates of the original Brewster setup. They are inclined toward each other at a relatively large angle of approximately 2° in order to project a complete set of clear white-light fringes. The tilting interfaces and their extensions form an air wedge, the apex of which is the fixed *X* axis of the optical system when the plates are in the null position.

The angle of the air wedge between the two Brewster plates is dependent upon the number of fringes desired, and varies with the focal length of the viewing telescope employed. It can be somewhat larger than 2°, but not much smaller.

The other orientation of the Brewster plates is the sensitive *Y axis* (the O'Donnell *sensitive axis of displacement*) about which the *V* plate of the Brewster pair is rotated. It is perpendicular to the *X* axis.

It is about the *Y* axis that null settings are made for several types of torsional determining interferometers, and for the very slight angle displacements measured by the surface-plate-flatness testing interferometer. As compared to the angle of inclination of the two interfaces about the *X* axis, rotation about the *Y* axis is very small. Rotations of less than 0.1 sec of arc can easily be observed and their amplitudes measured in numbers and/or fractions of displaced interference fringes, which in turn can be converted into seconds of arc.

Directional fringes

The Brewster interference fringes observed in this optical arrangement are fringes of direction, not of position, so they cannot be used for linear measurements. In addition, they are fringes of equally inclined planes, not fringes of equal inclination. They appear to originate at infinity, as do Haidinger's circular monochromatic fringes of equal inclination (see below), and move with the observer's eye in a cross-fringewise direction across the aperture of the interferometer.

Since the observer's eye, along with the observed fringes, will move a small amount during an observation, and because the eye has no markings on its retina which can be used for a reference position, the practical and only accurate way to determine fringe displacement is to use a mounted, collimated telescope containing a fiducial *AA* line or filament inscribed on a reticle.

The telescope axis is aligned with an oblique ray traveling in the *AA* plane and emerging from one side of plate *P*, when the *P* and *V* plates lie in their null orientation. When this is done the central white-light fringe lies centered on the fiducial filament of the telescope. Fringes appearing above the fiducial filament are designated plus-order fringes; those below, minus-order fringes.

When the interface surfaces of the inclined plates are parallel with the *X* axis, the central white-light fringe always is oriented parallel with the P-V_1 line of intersection (the *X* axis or null orientation).

However, when the interface of the V_1 plate is rotated about the *Y* axis, the fringes tilt parallel with the new P-V_2 line of intersection, the amount of tilt depending upon the amount of rotation. This is because of the differences in path lengths traversed by the rays which travel in the *AA* plane.

The difference in path lengths increases as the angle of incidence in the plane *AA* increases, as the index of refraction of the plates decreases, and as the thickness of the plates is increased.

The central white-light fringe is used solely for identification and for determining the null (parallel) orientation of the tilted Brewster plates about the *Y* axis. In calculating the angle of displacement between rays reinforcing the centers of neighboring fringes, the mercury 5461 A green line is used.

In the accompanying oblique sketch (Fig. 6) of a simplified O'Donnell-Brewster optical system, the interface surfaces *P* and V_1, and their extensions are shown outlined in solid lines. These planes and their extensions intersect at an *X* axis, which is the PV_1 line of intersection, when their interfaces lie in their null orientation with each other.

In this condition, the interface

edges of the P and the V_1 plates which lie in the AA fiducial plane (A-B and C-D), lie parallel to each other, parallel to the upper interface edges Pa-Pb and Va-Vb, and parallel to the PV_1 line of intersection, and the central white-light fringe will appear positioned at infinity in the AA plane as extended. The portions of the AA plane are shown in the sketch.

Dashed lines outline the V_2 position of the interface surface V_1 when it has been rotated 0.01° about the sensitive Y axis, which is perpendicular to the X axis. In this condition, the intersection of V_2 with the AA fiducial plane is along the line E-F, which lies at an angle of 0.01° with line A-B on interface P. The point in space at which these two lines converge is designated the PV_2AA vertex. Note that the PV_2AA vertex lies in the triangular-shaped AA plane extension to the left.

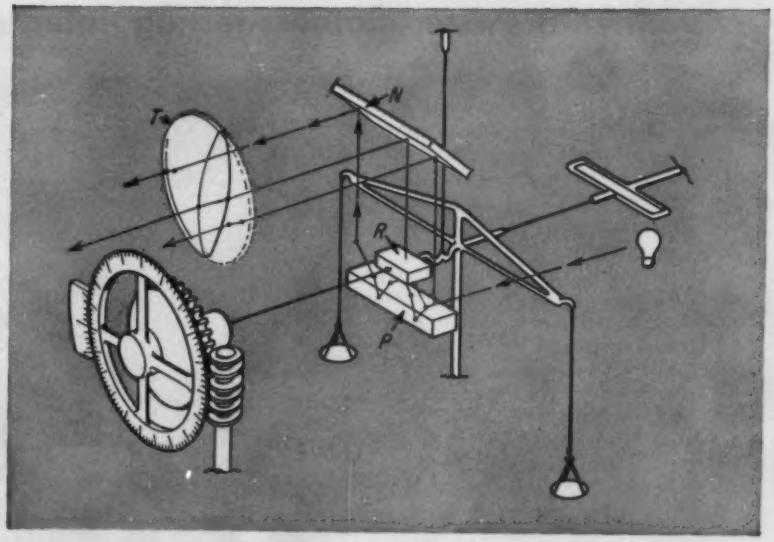
Since the V_2 interface surface has been rotated about the Y axis, which crosses and is normal to the PV_1 intersection at point Y_2, this point is common to both interface extensions. Geometrically, the point Y_2 is connected to the PV_2AA vertex with a straight line. Since both the P and the V_2 interface-surface extensions pass through both these points, the intersection of these planes is the PV_2 intersection—which is the *out-of-null intersection*. It tilts toward the PV_2AA vertex.

Since the white-light fringe system in all cases appears oriented parallel to the PV intersection, the white-light fringes now appear sloped in a direction parallel to the tilted PV_2 position.

The group of white-light fringes will move rapidly toward the PV_2 intersection as the V_2 interface surface is being rotated when viewed at an angle of incidence such as 45°. Ray $Z_{45°}$ is shown traveling from light source S to the observer's eye at this inclined angle in the AA plane.

Torsional interferometers

During World War II and later years, the University of Chicago's shops constructed a number of very precise quartz-fiber torsional microbalances with capacities ranging from 20 milligrams to 5 grams, with an absolute sensitivity of two billionths of a gram. The later and larger models, which had to be constructed to an absolute sensitivity of two hundred-millionths of a gram (equivalent to detecting four parts in a billion), employed modifications of the O'Donnell-Brewster torsional interferometer for ultra-precise alignment of the balance beam (Fig. 7).



7. Torsional interferometer has a sensitive reference mirror R attached directly to the beam of this *Chicago* 5-gram quartz-fiber torsional microbalance. Mirror R faces the reflecting interface of plate P of the O'Donnell-Brewster interferometer to reflect an imaginary surface that srves as the V interface to develop interference fringes and thus provide an exact indication of the null position of the microbalance beam. Fringes are viewed through telescope T and reflecting mirror N, so operator can remain seated at bench

Where the P and V elements of the O'Donnell-Brewster optical system are real glass plates in most applications, one (the P unit) is real and the other (the V unit) is virtual (imaginary) in the null torsional interferometers used with the microbalances.

Instead of the V plate, the reflecting surface of a sensitive reference mirror was employed in the bisecting plane R, which is an imaginary surface in the normal O'Donnell-Brewster setup. This mirror, which reflected a virtual image of the P interface to replace the usual V interface, was either suspended from a vertical torsional quartz fiber (Fig. 7) or held between two horizontal quartz fibers to lie in the center of the R bisecting plane and perpendicular to the PV_1 intersection formed by extensions of the real P and virtual V_1 interface surfaces when oriented in the null position of the microbalance beam.

Increased sensitivity

Use of the R mirror in place of the V plate actually doubled the sensitivity of the torsional interferometer in these applications. This is true because for a given rotation of plate V in a normal O'Donnell-Brewster instrument, the virtual wedge-bisecting plane R turns only half as far. Conversely, therefore, rotation of the virtual surface V in the torsional interferometer will be twice that of the actual mirror R, and the interference fringes will move twice as far as if developed by a real V interface turned through the same angle as R.

Optics rearranged

Several different arrangements of the P plate and the R mirror were made when constructing the various microbalances—all with about the same degree of success, though later units were much simpler than earlier ones. The interferometers' resolution was more than twenty times better than that obtained with the filament coincidence method employed in previous quartz-fiber torsional microbalances. With air Brewster plates and increased plate thickness, we could very easily have bettered the coincidence setting another ten times or more.

Application of the O'Donnell-Brewster null-setting principle to precision microbalances followed by some 20 years use of the same idea in an O'Donnell-Brewster null-setting torsional interferometer devised to check frictional relationships between a precision leadscrew in a Michelson ruling engine and its companion nuts and bearings.

O'Donnell-Brewster flatness-testing interferometer

Here is an instrument capable of checking the flatness or straightness of surface plates and machine ways of any convenient size—within the limits of the light source—to within fractions of a wavelength of light. It is of simple construction, and is relatively easy to use.

Two small 6 x 6-in. optical assemblies, each supported on three hardened, ground, and lapped tool-steel pads spaced at the corners of a 5-in. open square, and a vertical collimating telescope, make up this interferometric flatness tester (Fig. 8, 9).

One of the optical units, the sensitive R_1R_2 90° corner reference mirror assembly, has two optically flat mirrors permanently mounted perpendicularly to each other and to the plane of the surface upon which the three supporting pads rest. This is the assembly that is moved about the surface being inspected.

The other assembly carries the Brewster P and V plates in fixed facing mounts, directly opposite each other. Both the P and the V plates are oriented at 45° with the supporting surface, but in opposite directions so they slope away from each other. Slope of the interface of the P plate is optically positive, that of the V plate is optically negative.

In normal use, the R_1R_2 unit becomes a ghost unit, since its only function is to tilt the imaginary V_3 virtual Brewster plate (Fig. 9) about a Y_3 axis when R_1R_2 is moved across areas of the surface being checked which are out of parallel with the area on which the PV_1 unit rests. In the plan sketch only essential optical members are shown to avoid confusion in the projection of the virtual image V_2 of plate V_1 as reflected by the R_2 flat mirror, and of the V_3 virtual image of virtual V_2 as reflected by the R_1 flat mirror.

The X_1 and X_2 axes indicated, about which the real Brewster plate P and the virtual-virtual plate V_3 are oriented to project a group of white-light fringes, lie parallel to the X axis described previously. Similarly, the P and the virtual V_3 plates are oriented about separate Y_1 and Y_3 axes which lie parallel with the sensitive Y axis of displacement of the optical system.

The doubly reflected interface edge of the virtual V_3 image of plate V_1 lies parallel with the interface edge of plate P when (a) the R_1R_2 unit rests upon a plane positioned parallel with the plane supporting the PV_1 unit, and (b) each of the R_1 and R_2 mirror surfaces is accurately oriented 90° with the surface being inspected, as well as with each other.

8. O'Donnell-Brewster flatness testing interferometer permits observer to watch through telescope above PV_1 to see if central white-light fringe moves to right or left of fiducial element as reference mirror unit is positioned in 5-in. steps along a line across the surface plate

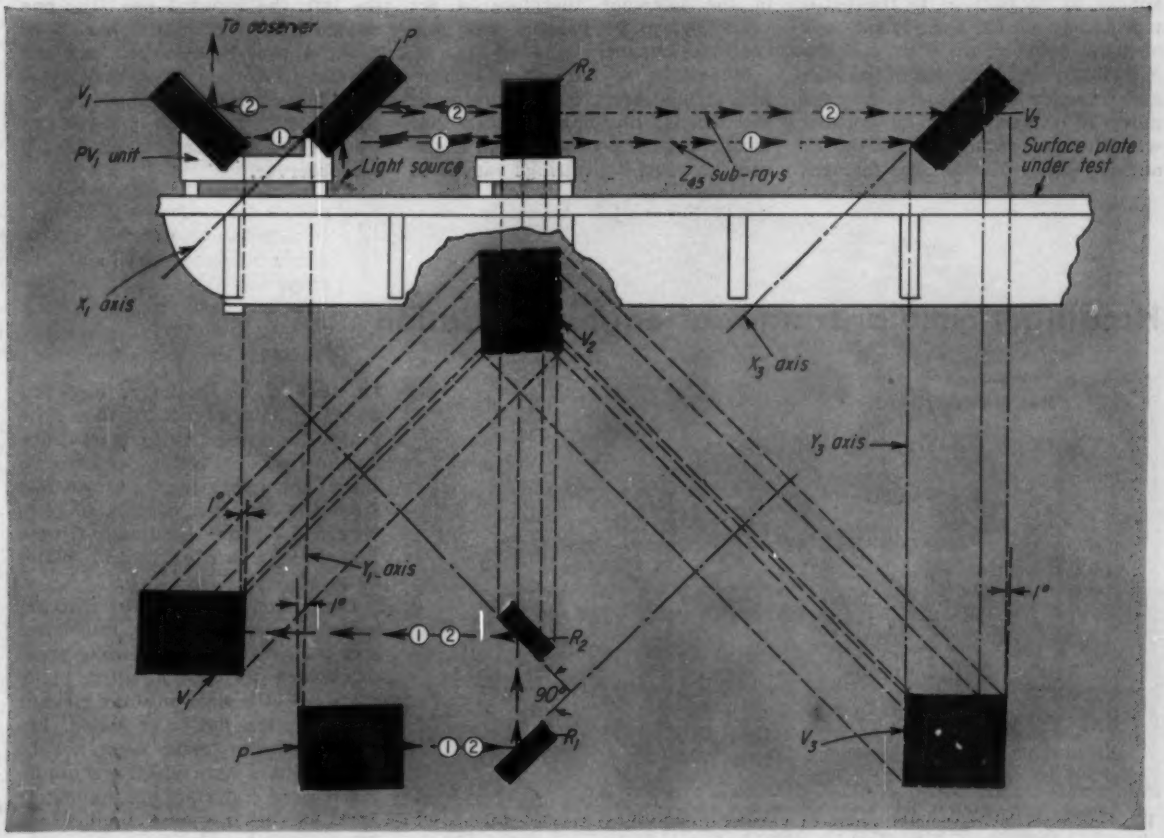
Should the R_1R_2 unit be moved to a section of the surface plate that is out of parallel with the area on which the PV_1 unit rests, the virtual-virtual edge of the V_3 image of V_1 will be slightly out of parallel with the interface edge of P, because the R_1R_2 mirror combination will have been tilted out of vertical to the plane supporting PV_1 unit. If this tilt is not too great the white-light fringes will remain in the field of view, will be displaced, and the central fringe will move away from the fiducial filament in the viewing telescope.

Moving the R_1R_2 unit to another position does not change the orientation of the (1) and (2) sub-rays as viewed from above, since the R_1 and R_2 mirrors are auto-collimating in the plane of the supporting surface. However, as viewed from the side, the R_1R_2 unit is sensitive to any waviness in the supporting surface and will return the (1) and (2) sub-rays to the PV_1 unit out of parallel with the outgoing rays emanating from that unit.

Shown in the photograph above (Fig. 8) is a simple working model of the flatness testing interferometer used for demonstrations at The University of Chicago's Physical Sciences Central Development Shops.

The P and V_1 plates in this assembly are 1-cm-thick, precisely parallel plates of Crown Optical Glass, each of which has opposite faces parallel within ±0.1 green mercury fringe. Rear surfaces of these plates are aluminized with a 100% reflective coating, while the interface surfaces have 37% reflective coatings.

Because the P and V_1 plates are made of an optical glass whose index of refraction is 1.5252, are oriented 45° with the plane of the surface supporting both the PV_1 unit and the R_1R_2 unit, and are oriented to each other about parallel X axes and make an angle of 2° with each other for projecting white-light



9. Optical arrangement of flatness testing interferometer, sketched above in front-elevation and plan views, shows paths of light rays and their sheared sub-rays as they pass between the PV_1 and the R_1R_2 optical assemblies. In the plan view the V_1 plate is projected to virtual position V_2 and then to V_3, simulating the *PV* Brewster setup.

fringes, if the R_1R_2 unit is moved onto an area that is inclined 0.005° with the reference plane of the PV_1 unit, the difference in paths traveled by a ray of light and its *sheared* sub-rays (1) and (2) in passing through the interferometer is calculated to be ±1.293 microns. This will move the center of the central white-light fringe 2.37 mercury monochromatic light fringes (which to the average eye are spaced about the same distance apart as are white-light fringes) from its null position of coincidence with the *AA* fiducial filament in the viewing telescope *T*.

Because the supporting pads under the R_1R_2 unit and the forward and center pads lie approximately in line with similar pads under the PV_1 unit, when the R_1R_2 unit is tilted 0.005° from an accurate reference plane, the difference in heights of the surface under the forward and rear support pads spaced 5 in. apart can be shown to be 0.000,872,5 in. This can be reduced to approximately 0.000,37 in. difference (0.000,872,5 ÷ 2.37) in surface heights between areas separated 5 in. apart for each full fringe displacement observed in the viewing telescope when using the green line of mercury.

An experienced observed easily makes fractional fringe displacement determinations to an accuracy of at least 0.1 green fringe. The limit of accuracy, then, for height differences measured with the demonstration flatness testing interferometer is about ±0.000,037 in., or 3.7×10^{-5} in. For a 96-in.-long surface plate, this could mean an accumulated reading error of a little more than 0.0007 in., obviously too great an error for a precision plate.

Had the interferometer been constructed with similar *P* and V_1 Crown Optical Glass plates 10-cm thick, instead of 1-cm thick, the sensitivity would have been increased in direct proportion, or ten times. It would have become 3.7×10^{-6} in./5 in./0.1 fringe displaced at the *AA* fiducial filament in the telescope.

Special Brewster air plates 10-cm thick in place of the 10-cm-thick Crown Optical Glass plates would have increased the sensitivity of the interferometer still further, even for the same angle of incidence. With 10-cm air plates (which have a refractive index of 1) oriented at 45°, as above, sensitivity would have been increased three times over that possible with the 10-cm glass plates, or to approximately 9×10^{-7} in./5 in./0.1 fringe displacement.

Changing the angle of incidence of the air plates from 45° to 70° would have further improved the sensitivity.

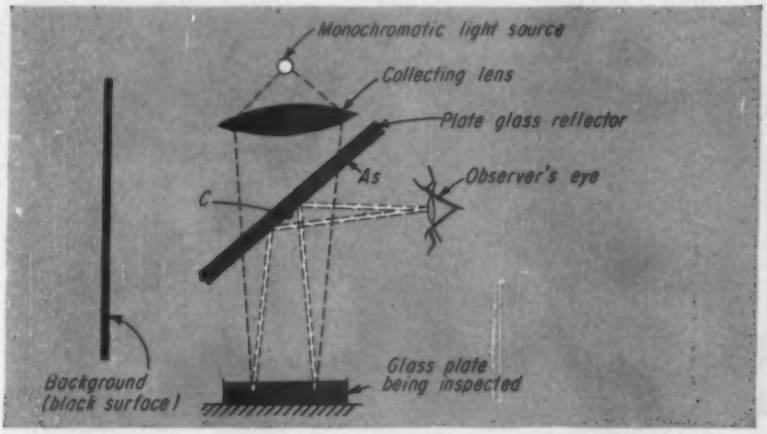
Direction of displacement of the central white-light fringe from the vertical *AA* fiducial filament in the reticle of the telescope indicates immediately to the observer which of the two support pads is above or below the other when the R_1R_2 mirror unit is tilted toward or away from the PV_1 unit.

If the observer is positioned back of, and in line with, the PV_1 and the R_1R_2 units, and views downward toward the reflected fringes projected into telescope *T*, the fringes will

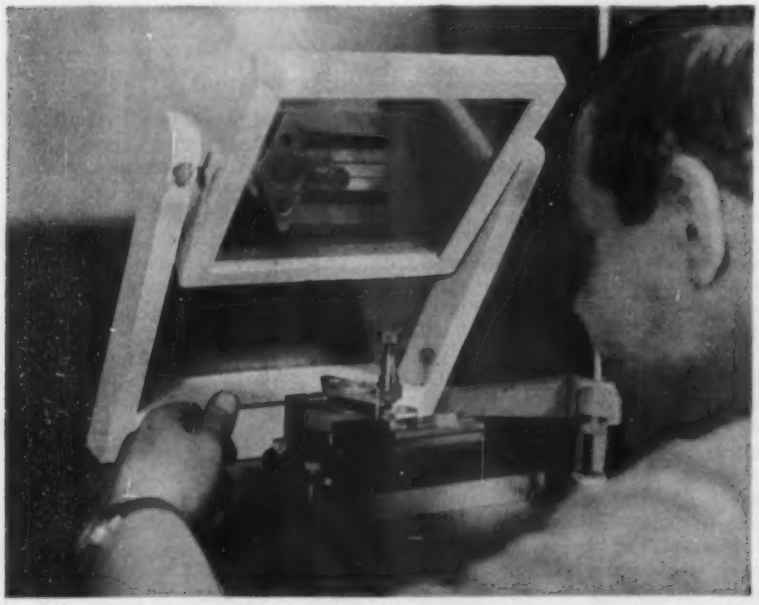
appear to lie parallel to the paths traveled by the (1) and (2) sub-rays of light between the PV_1 and the R_1R_2 units. (As indicated in the plan and elevation sketches, the sub-rays move in a vertical plane parallel with the one passing through the X_1 and X_3 axes.) The fiducial filament in the telescope therefore is set vertically, to be parallel with the observed fringes.

Movement of the central white-light fringe from coincidence with the fiducial filament indicates that the R_1R_2 unit has been tilted. If the central white-light fringe moves to the left, the forward pad (the one nearest the PV_1 unit) has been raised above the rear pad, and the mirrors have been tilted back away from the observer; if it moves to the right, the forward pad is lower and the mirrors have been tilted toward the observer.

Haidinger circular fringes of equal inclination



10. Haidinger interferometer produces circular interference fringes of equal inclination which are used to check parallelism of opposite faces on the optical flat under inspection. Fringes are observed in the tilted plate-glass reflector. Light source is a monochromatic mercury lamp



11. Observation of Haidinger circular fringes reflected in tilted mirror above O'Donnell-Haidinger interferometric comparator tells inspector whether workpiece is of the same size, larger, or smaller, than master gage block used to set comparator's optical flats parallel at zero position. Light source (not shown here) is directly above mirror

In 1849 W K Haidinger observed bands of interference in thin mica plates illuminated by light transmission instead of reflection, and termed them lamellar fringes, as distinct from the reflected contact rings of Newton. We use Haidinger fringes for testing parallel optical plates (Fig. 10).

Light from an extended mercury monochromatic source is broadened and projected as a converging beam downward through a tilted plate-glass reflector plate onto the glass or quartz optical flat to be tested. The tilted reflector plate need not be coated, but is more effective if aluminized so it transmits approximately 50% of the incoming light beam. The coated *As* side always is on the side toward the observer, as indicated in the sketch.

Rays appearing to originate in the broadened light source pass through the tilted glass reflector to the plate being inspected, and are reflected back to the tilted reflector by the top and bottom faces of the test plate, then to the eye of the observer. The inclined rays which are subdivided by the upper and lower surfaces of the test plate return to the inclined reflector as two slightly displaced sub-rays, which come to a focus on the retina of the observer's eye.

It is essential that the center of the test plate be viewed normally (that is, perpendicularly). This is done by positioning a dark spot or cross *C* on the front face of the tilted reflector plate. By aligning the mark *C* with its virtual image in the test plate, either by shifting the eye or by changing the angle of tilt of the reflector, a circular fringe pattern will appear with its central dot fringe in coincidence with the fiducial markings.

Expansion or contraction of the circular Haidinger fringes as the eye is swept across the view of the test plate indicates variations in thickness of the test plate.

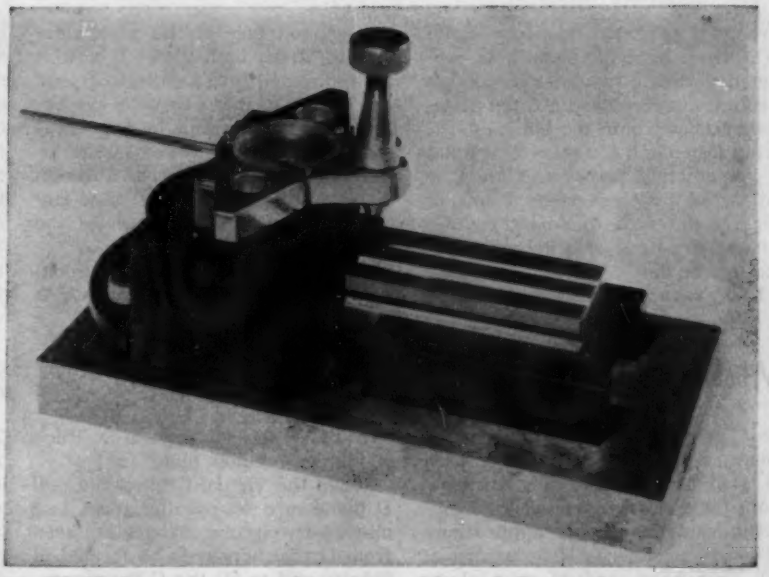
The same principle is employed in a simple, inexpensive tilting-plate comparator (Fig. 11) made in our shops for checking shop gage blocks against masters of the same nominal height, and for sorting small bearing balls and other precision parts into lots within small dimensional tolerances. Depending on the location of the fulcrum on which the tilting plate of the comparator assembly is mounted, this instrument can check parts accurately to within one-tenth of a wavelength of the monochromatic light used.

The tiltable plate of this comparator (Fig. 12) carries a small, round, glass optical flat, preferably made of plate glass or quartz, with opposite surfaces slightly out of parallel. The bottom, and flat, face of this optical flat has a 50% reflective coating that returns half of the incoming vertical light beam, and permits the other half to pass through onto the reflecting flat top of a similar but fully coated optical flat in the base of the instrument. When the reflecting faces (interfaces) of the two optical flats are precisely parallel, the comparator is in balance.

Displacement of interference rings in this instrument is the result of unequal light path lengths in an air wedge. In the case of the optical flat tester (making use of Haidinger interference fringes), the displacement is the result of unequal light path lengths in a glass wedge.

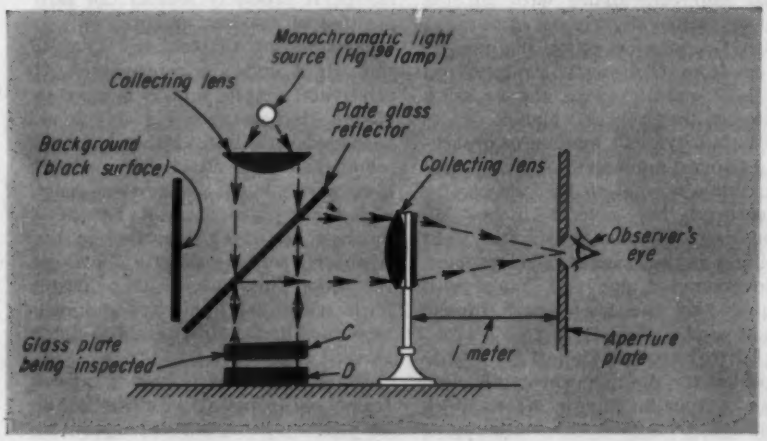
To set the comparator for a given size, a master gage block is positioned on the work table and a contact screw on the tiltable comparator plate is adjusted until Haidinger interference rings remain unchanged in size as the operator's eye sweeps across the aperture. Contact point wear is not a problem with this instrument, because the zero point is reset for each job.

With the comparator set to a given gage block, the operator uses a control rod to tilt the comparator plate so he can exchange the gage block for a workpiece to be checked. If, when he lowers the comparator plate so the contact point rests on the workpiece, and he sweeps his eye across the aperture, the reflected interference rings do not change in size, the workpiece is of the same height as the master gage block. However, if the interference rings appear to enlarge or contract, the workpiece is larger or smaller than the master—the amount of size shift indicating the amount of error in the workpiece dimension.



12. Tiltable brass comparator plate rests on fulcrum balls in sockets machined in side support blocks of O'Donnell-Haidinger interferometric comparator. When instrument is in balance, reflecting surfaces of the tiltable and the fixed optical flats are exactly parallel

Fizeau circular fringes of equal thickness



13. Fizeau circular fringes of equal thickness are observed in this interferometer devised by Michelson for checking the surface accuracy of an optical flat *C* directly above master flat *D* under the monochromatic light source. Resultant fringes are true grade contour lines

In 1862 Armand Fizeau produced Newton's rings by supporting a very long focal length lens directly above a flat reflecting surface. He added a collimating lens above the first two optical elements for the purpose of illuminating their full surfaces, and for returning the reflected beam to the observer's eye.

If one of the interfaces in Fizeau's experiment were irregular, the fringes observed by looking down through the lenses from a position near the light source would be distorted, and would represent the topographic contour of that interface.

Michelson, in 1898, developed a modification of the Fizeau interferometer to test face surfaces of optical flats. This instrument still is in use at the University.

In this Michelson-Fizeau inter-

ferometer (Fig. 13), monochromatic light from a mercury bulb is projected vertically downward through a collimating lens and a tilted plate-glass reflector onto the optical flat *C* being tested and a master optical flat *D* immediately below it. Plate *C* is supported by thin paper shims of slightly different thickness (within ±0.0002 in. limit of differences) on the master flat.

Light rays reflected back onto the 45° inclined face of the plate-glass reflector from both plates *C* and *D* are redirected into a collecting lens, and thence to the observer's eye behind a small opening in a vertical aperture plate. Contoured Fizeau interference fringes observed through the collecting lens clearly show any irregularities in the surfaces of the plate *C* being inspected.

The Fizeau fringes of equal thickness observed in this setup appear to be localized between the two plates, and are evaluated in the same manner as those observed through an optical flat under a monochromatic light. In fact, the only major difference between this setup and the conventional optical flat method is the collimination of the light rays after they leave the light source. The fringes developed are true contour lines spaced one-half wavelength of light apart.

Michelson's right-angle interferometer

This combination comparator and measuring instrument has been used in a number of different modifications for a variety of precision measuring and inspection applications. It can be read easily to accuracies of 0.1 light band, and to even closer tolerances if vernier scales or optical methods are used to measure fractions of band widths.

Michelson's interferometer also has been applied to many other uses —the Twyman-Green modification, for example, is acclaimed as the best means available today for checking the accuracies of optical lenses and prisms.

Devised in 1882 as the Michelson interferential refractometer, the basic instrument was first used as an aid in measuring the speed of the earth through space. In its simplest form, it incorporates four optical members: the parallel glass plates *A* and *B*, and the back mirrors *C* and *D* mounted accurately at 90° to each other and at 45° with plates *A* and *B* (Fig. 14, 15).

With this arrangement, a beam of light is split, amplitude-wise, at the coated face *As* of plate *A* into two pencils of light. One pencil passes through *A* and is projected onto mirror *C* for reflection back to the recombining face *As* and thence to the observer.

The second split pencil of light is reflected by *As* through the compensator plate *B* onto mirror *D*, which may be adjusted normally with its front face (to suit various measuring conditions) by movement of its supporting carriage. The second pencil of light is reflected by *D* back through plate *B* to recombining surface *As* for transmission along with the first pencil, to the observer.

What this optical arrangement does, in principle, is to project in front of mirror *D* a virtual (imaginary) image *Cv* of mirror *C*. Mirror *D* and image *Cv* thus simulate the two reflecting surfaces of a thick Haidinger parallel plate.

When the virtual *Cv* and the real *D* planes are set parallel and 1 to 2 mm apart, circular fringes are seen from *O* that appear to be located at infinity and to fill the *C-D* aperture.

Optically, the effect is the same as in the Haidinger thick parallel plate setup, or in the real *C* and *D* mirror arrangement of Fizeau's setup.

There is, however, an important difference. Unlike the Haidinger and the Fizeau setups, the Michelson interferometer does not develop extraneous reflections between parallel plate surfaces. The *Cv* surface is not a real surface and therefore cannot, by reflection, return part of the light it receives from surface *D*.

In addition, the Michelson interferometer is the only interference instrument that permits use of white light alternately with monochromatic light (see duplex lighting arrangement in Fig. 14) without risk of disturbing the position of either surface by contact or near-contact.

If, when mirror *D* is adjusted to pass into coincidence with surface *Cv*, it is tilted slightly out of parallel with *Cv*, or vice versa, the fringes seen from *O* become straight and will be parallel with the crossing between the *Cv* and *D* planes.

With Twyman's method of observing fringes, movement of *D* in either direction normal to its face can be measured for several inches by counting the monochromatic light fringes as they pass a selected point. Movement of one full fringe will equal half the wavelength of the light used.

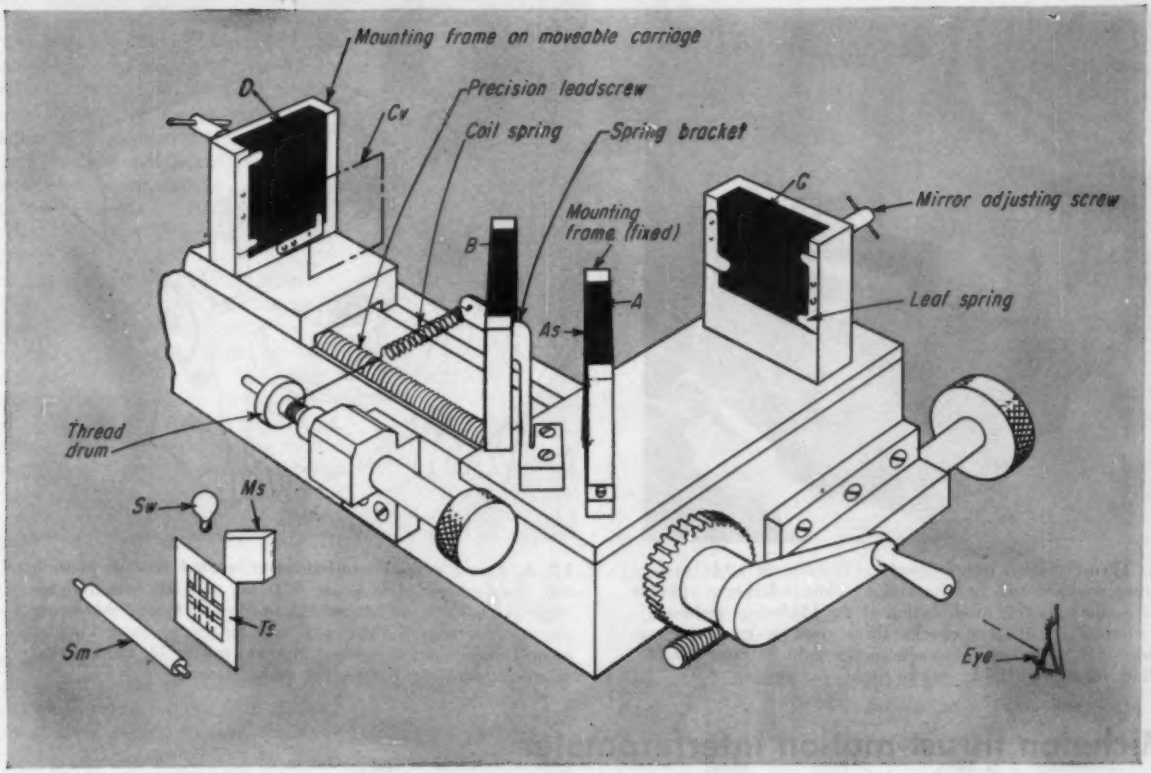
Furthermore, if white light is substituted for the monochromatic light (as by turning mirror *Ms* to block out light from monochromatic source *Sm* and reflect light into the interferometer from white-light source *Sw*), and the two interfering optical paths (*As*-to-*C*-to-*As* and *As*-to-*D*-to-*As*) are equal in length to within a few wavelengths, several fringes on both sides of the *Cv-D* line of coincidence (intersection) will be colored white-light fringes.

These color fringes are localized and located close to the plane of the back mirrors. By moving the mirror *D* back or forward slightly we can shift the line of coincidence across the aperture of *Cv-D*. Along this line a black or white central fringe will be observed—it corresponds to the black or white spot observed in Newton's reflected or transmitted rings, and its location in the *Cv-D* aperture marks the point where the path difference between the *C* and *D* arms of the interferometer equals zero. This fringe then can be used to identify a particular monochromatic fringe line as the zero position of the interferometer. For this reason it is called the *identifying* central white-light fringe.

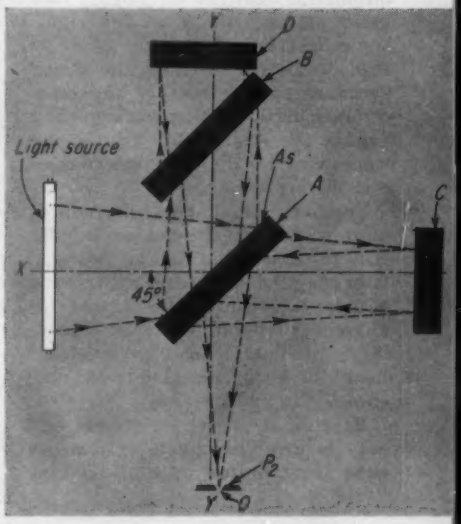
It is this fringe that peculiarly adapts the Michelson interferometer to comparison of standards of length, and to precision linear measurements. It precisely locates the zero position of the instrument.

Construction of the basic Michelson right-angle interferometer is relatively simple, and it is easy to adjust. Its base (see Fig. 14) is an L-shaped cast-iron block. Optical members *A* and *B* are flat, parallel glass plates, cut from the same piece of optical glass after it has been finished accurately parallel so the two parts will be exactly the same thickness. Their faces must be parallel to within 0.1 lightwave and each face must be flat to within 0.05 lightwave.

Dividing plate *A* is held in a fixed frame and is mounted on the base so its beam-splitting and superpositioning (recombining) surface *As* is centered at the crossing of the *X* and *Y* axes of the optical system (see Fig. 15) and bisects the right



14. Michelson's right-angle interferometer, when properly made and adjusted, is a precise measuring instrument capable of checking longitudinal dimensions within a millionth of an inch under normal shop precision inspection conditions. Target plate *Ts* aids in aligning the optical elements



15. Four optical elements—dividing plate A with beam-splitting and recombining surface *As*, compensator plate *B*, and back mirrors *C* and *D*, make up the optical system of the Michelson right-angle interferometer. Both white and monochromatic light can be used ▶

angle formed by these axes. Surface *As* is partially spattered or plated with silver or aluminum so it transmits approximately 50% of the incoming light beam and reflects the other 50%. We prefer a coating of aluminum applied by evaporation in a vacuum chamber.

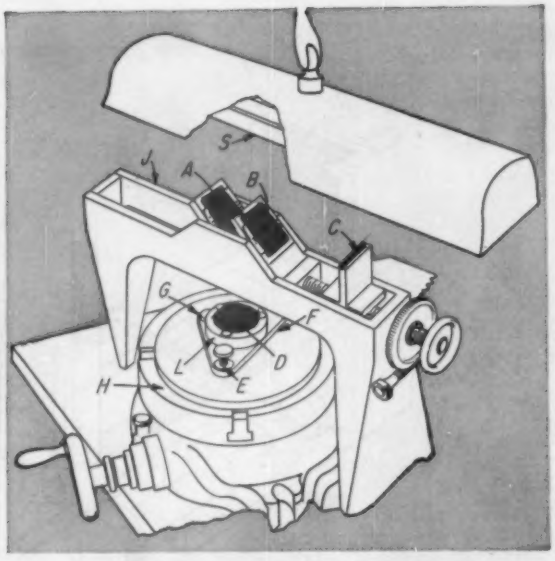
Compensator plate *B* is mounted in a fixed frame precisely parallel with plate *A* (this can be accomplished with Brewster's fringes as described previously) and facing the coated *As* side of *A*. It is mounted as close to *As* as possible, but not so close as to cut off part of the entering or exiting pencils of light.

Compensator plate *B* serves two purposes. Its primary function is to make the length of the optical path traveled by the reflected pencil of light in the *D* leg of the interferometer the same as that of the path traveled by the transmitted pencil of light in the *C* leg, which must pass twice through plate *A*.

Its second and very useful function is to adjust slightly the length of the optical path in leg *D*. By turning plate *B* only a small amount about a vertical axis, the length of this path is increased or diminished sufficiently for precision fringe settings, and for making precise fringe displacement determinations. For this purpose, the frame that holds plate *B* in the interferometer is supported by a spring bracket, to the outer end of which is connected a coil spring and a tensioning cord whose pull is adjusted by a drum on the side of the instrument's base.

While compensator plate *B* is not entirely essential to the functioning of the interferometer, it is essential if clear white-light fringes are desired. Without the compensator, white-light fringes are curved, indistinct, and appear to rock-and-roll with side movement of the eye across the interferometer's aperture —nor do they lie on the same plane with the fiducial line on the back of mirror *C*. If compensator *B* is omitted, distinct, easily visible fringes will be seen only when the light source is changed to send collimated pencils of light through the interferometer. This is done in the Twyman-Green interferometer, an instrument used to check optical prisms.

16. Thrust motion interferometer.—Wobble of table surface during rotation can be checked to close tolerances quickly and easily with this modification of the Michelson right-angle interferometer. It also checks thrust motion errors in machine tools spindles. Monochromatic light is used for locating mirror on table, white light for testing



17. In thrust motion interferometer, coated face of plate A and compensator plate *B* are in *C* leg of a Michelson right-angle optical system. Mirror *D* is on top of index table being checked for wobble. Mirror *C* can be set to show circular monochromatic fringes when aligning mirror *D*, then moved to use white-light fringes for measurement

Michelon thrust-motion interferometer

A white-light straight-fringe interferometric method employing the basic optical circuit of his right-angle interferometer was used by Prof Michelson to check the thrust accuracy of the butt of the lead-screw in his diffraction grating ruling engine. The straight-line fringes also were used to align the interferometer during setup.

Because alignment procedures with white-light fringes were difficult to understand and to follow, I later devised a modification using circular monochromatic fringes for alignment operations while retaining white-light fringes for measurements of displacement due to inaccuracies in axial thrust.

Because it proved so simple and easy to use, this optical system has been incorporated in a bridge-type interferometer (Fig. 16, 17) especially suited for checking thrust motion and wobble errors in precision rotary index tables for jig borers. The same unit also has been employed to check axial thrust and wobble inaccuracies of the spindle in a precision grinder specially arranged for generating spherical, ellipsoidal and parabolic internal and external surfaces.

The *A*, *B* and *C* members of the Michelson right-angle interferometer's optical system are, in this instrument, mounted on a bridge-type base *J* which, when set up on a surface, spans the index table *H* to be inspected. The bridge rests on three support pads so it will not rock or twist if the surface plate is not plane. Compensator plate *B* is mounted between reflecting face *As* of dividing plate *A* and mirror *C*.

Mirror *C* is in a fixed mount on an adjustable carriage that permits *C* to be moved along the axis of the optical system normal to its reflecting surface. This permits *C* to be moved close to plate *B* during alignment operations so circular monochromatic interference fringes will be seen clearly, and to be moved back until legs *C* and *D* of the interferometer circuit are optically equivalent and straight white-light interference fringes are developed.

Mirror *D* is mounted centrally on dividing table *H* in a frame *L* which has two leveling screws *E* and *F* that are equilaterally spaced in relation with a fixed pin *G*, so the mirror's reflecting face can be leveled and supported on three equally spaced points.

Michelson parallel interferometer

Versatility of the right-angle interferometer was increased considerably when Michelson placed back mirror *C* on an adjustable slide, like the one used to position back mirror *D*, and then turned the optical *C* leg 90° by adding mirror *E* (Fig. 18). This permitted stiffening the base of the instrument by making the ways for the two slides parallel. As a result, this instrument has been termed the Michelson parallel interferometer. It is the one Michelson and Benoit used when they measured the length of the International Meter in Paris in 1892-93.

Principal elements of a Michelson parallel interferometer arranged to calibrate rulings on scales ranging up to 6-in. long are shown in an accompanying sketch. Requirements for accuracy of size and location of the various optical elements of this instrument are the same as for the Michelson right-angle interferometer. In addition, the two carriages must travel exactly parallel with each other and their guiding ways must be flat and straight within 0.1 interference fringe over their length.

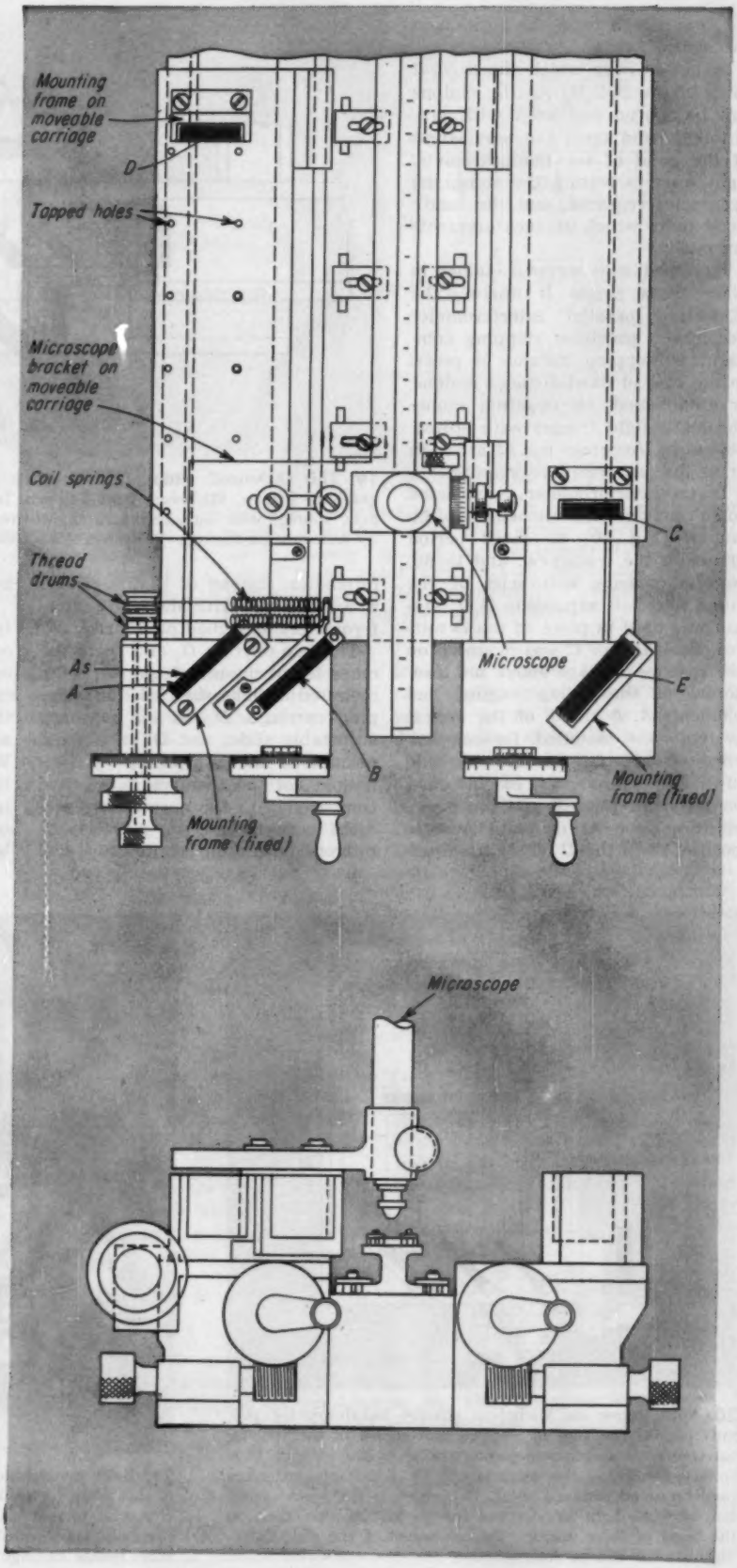
Duplicate precision leadscrews are provided for both carriages for smooth, easy adjustment of their locations. The carriage supporting mirror *D* carries on its forward end a toolmaker's microscope with which that carriage, and therefore the mirror *D*, can be located to a zero gage line on the scale being checked.

Mirror *C* is then set to zero from mirror *D*, using white-light fringes, and the first carriage is then moved either (a) until the microscope is centered with the next scale line, or (b) the carriage has been moved a measured distance and the microscope then is used to determine if the scale line is where it should be. In either case the distance the microscope has been moved along the scale is determined by counting monochromatic interference fringes as they traverse an index point on mirror *D* as it is carried along by its carriage.

In a variation of this instrument, I mounted a camera at one end (Fig. 19) and used a collimating lens and a pinpoint source of monochromatic light so periodic errors in a diffraction grating ruling engine could be recorded. Fizeau and Twyman interference fringes, as well as Michelson fringes, could be observed and recorded within this setup.

Versatility of the Michelson parallel interferometer for precise measuring operations can be increased by arranging the top face of the carriage for the *D* mirror with a longitudinal alignment keyway and a series of tapped holes for mounting interchangeable accessory variations of the *D* mirror.

These accessory back mirrors usually include both fixed and adjustable etalons in which the *D* mirror is split vertically into two or more equal areas. Those most generally used are the adjustable D_1D_2 etalon and the fixed five-step 5-cm and ten-step 1-mm etalons described below. These accessories aid in stepping off sizeable dimensions from a zero point established with Michelson white-light interference fringe procedures, without tedious counting of monochromatic light fringes as mir-



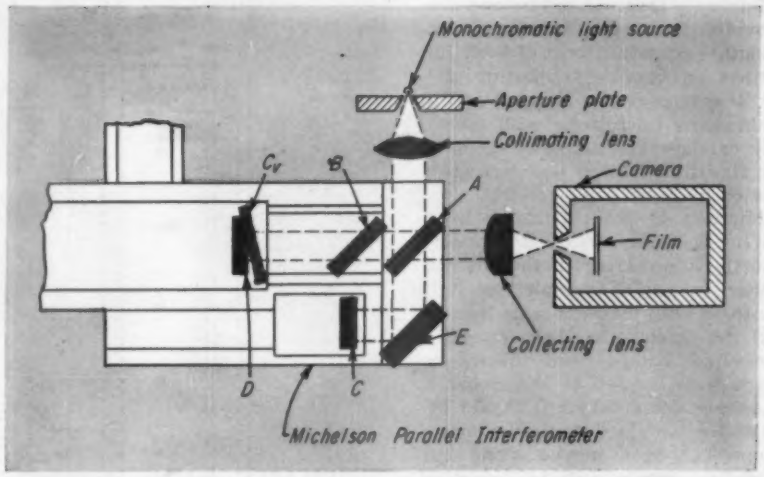
18. Michelson parallel interferometer has all the optical features of his right-angle unit, but is more flexible and can be made with greater capacity. It is especially useful for calibrating screws, scales, racks, and other parts requiring positioning accuracy down to approximately one millionth of an inch. Several modifications have been built in the University of Chicago shops

ror D is moved from one position to the next.

Distances over which the several faces of the $D_1D_2D_3 \ldots D_n$ etalons can be spaced and used with precision depend upon the narrowness of the band of the monochromatic light used in setting the steps, the accuracies required, and the conditions under which the measurements are made.

Equipped with stepped etalons in place of a single D mirror, the Michelson parallel interferometer becomes a precision stepping comparator. Stepping distance is preset in the case of fixed-distance etalons; or established by counting monochromatic light fringes with adjustable units. Accuracy can be as rough or as fine as conditions require.

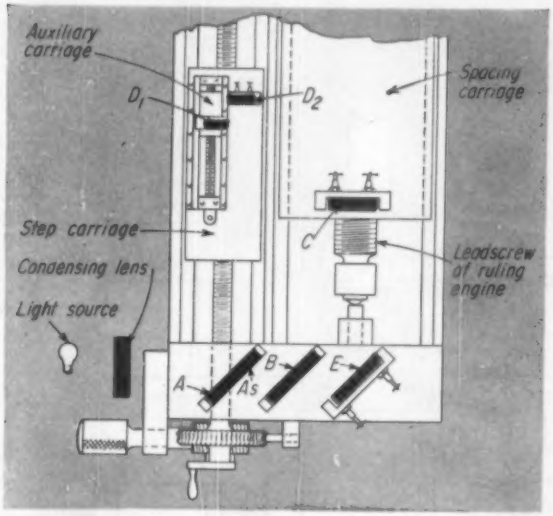
In an interferometer constructed some time ago on a Michelson ruling engine (Fig. 20) to check period errors in the leadscrew, and to determine spacing accuracies of the ruled lines, an adjustable D_1D_2 etalon was used in place of the D mirror. Back mirror C was mounted on the spacing carriage above the leadscrew of the ruling engine, and elements A, B and E of the optical system were mounted, for convenience of assembly, across one end of the interferometer. In this case, compensator plate B and the beam-splitting face As of plate A were positioned in the C leg of the interferometer, instead of in the D leg, as was the case with Michelson interferometers described previously.



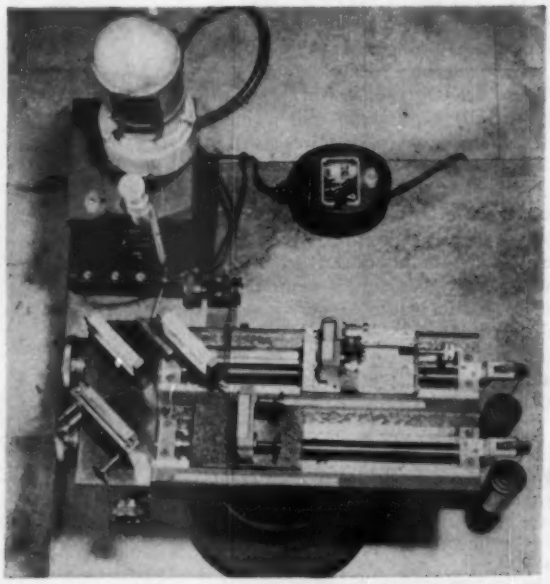
19. This O'Donnell setup of a Michelson parallel interferometer permits photographing Fizeau, Michelson, and Twyman fringes. Instrument employs a Twyman light source, with monochromatic light from a pin-hole source being collimated for transmission through the system, then collected for viewing

The two mirrors D_1 and D_2 in the other leg of the interferometer were mounted side-by-side on the stepping carriage, D_1 on an auxiliary adjustable slide, and D_2 in a fixed position as shown. Spacing determinations for the C mirror were then compared with the normal displacement between the D_1 and the D_2 mirrors, once their relationships had been definitely established.

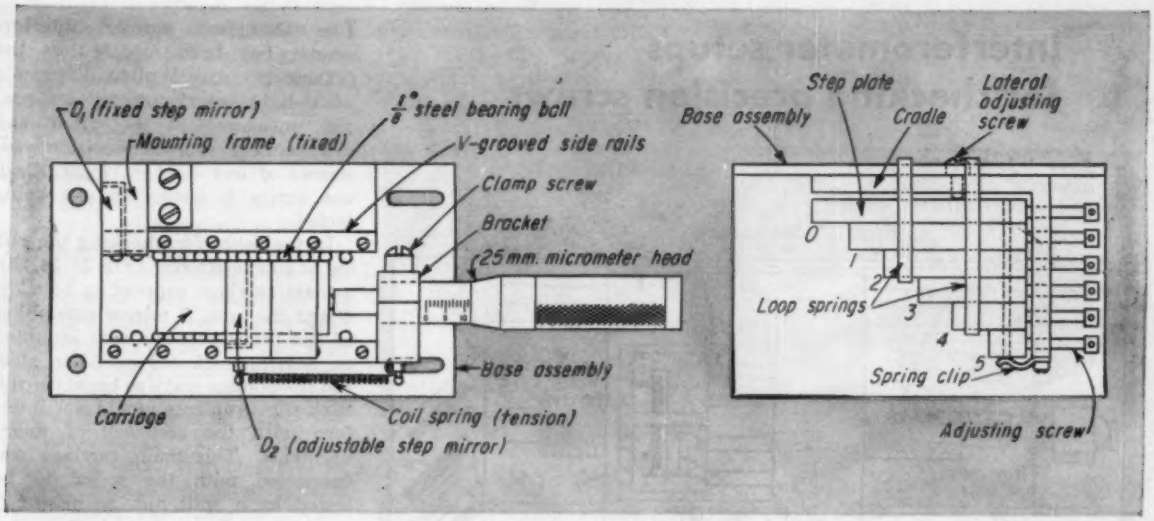
A fiducial line to which the identifying white-light central fringe could be referred in the D_1 and D_2 mirrors was established by mounting a line (a section of No. 5 black thread worked well) horizontally across the center of the C mirror. When the operator looked into the interferometer he could see the outer boundaries of the vertical aperture of C superimposed upon the outer boundaries of the combined aper-



20. Split mirror on Michelson parallel interferometer permits precise checking of stepped movements of the spacing carriage on a diffraction grating ruling engine. Mirror D is split vertically so the sections can be adjustably spaced a predetermined distance apart. By centering the black center line of white-light interference fringes first on one, then on the other of these mirrors, the movement of the slide carrying mirror C can be determined



21. Both monochromatic and white-light sources are used in this setup for calibrating short precision scales. Instrument is similar to that in Fig. 20. With D_1 and D_2 mirrors set a precisely known distance apart, ruling on scale placed on ways beside carriage carrying mirror C can be checked



22. **Micrometer-adjustable etalon** (left) makes use of a 25-mm micrometer head for easy, rapid changes in spacing between the D_1 and D_2 mirrors of a Michelson parallel interferometer. Once a setting has been made it can be checked for optical precision by counting the monochromatic light fringes between the two reflecting surfaces

Five-step fixed etalon can replace D mirror on a Michelson parallel interferometer to give precise indications of C mirror movement up to 5 cm. Unit consists of six, precisely parallel mirror plates, each set 1 cm behind the other and each 9/32 in. wide. Ten-step etalons (0.1 mm per step) have also been built and used successfully

tures D_1 and D_2, with the fiducial line reflected horizontally across their centers.

Once a position of the spacing slide had been determined, the C and D optical legs of the interferometer were made equal by centering the central black line of the white-light fringe system with the fiducial line reflected across either D_1 or D_2, depending on the direction in which the spacing slide was to be moved for its next position. This automatically located the other half of the D_1D_2 combination for centering the black fringe line when mirror C reached the next desired position.

The arrangement could therefore be used either to precisely locate mirror C, and the slide on which it was mounted, at predetermined intervals across the machine, or to determine the accuracy of the spacings of C across the machine, as established by microscopic examination of ruled lines or by turning the leadscrew a prescribed number of times. For the latter arrangement, errors between the actual position of C and that prescribed by the location of the D_1 or D_2 mirror could be measured by counting the monochromatic-light fringes needed to bring the D_1 or the D_2 mirror from its prescribed location into conjunction with the white-light centering fringe projected as a result of the actual location of the C mirror.

Here at the University's Physical Sciences Development Shops we built a similar arrangement into a smaller Michelson parallel interferometer, and used the instrument to calibrate short precision scales and to make other precise measurements over relatively short distances (Fig. 21).

Design of the adjustable D_1D_2 etalon was later improved by adding a precision micrometer head to the auxiliary slide that carries one of the step mirrors. (Which one is adjusted does not affect the action of the instrument.) In this arrangement (left, Fig. 22), the auxiliary slide holding the D_2 mirror was held against the head of the micrometer adjusting screw by a tension spring. Reflecting faces of the D_1 and the D_2 mirrors were kept perfectly parallel with each other and normal with the optical path of the D leg of the interferometer.

Fixed-step etalons for use in place of the D mirror also can be very helpful in making precise stepping comparisons. In our work we have found the five-step 5-cm (1 cm per step) etalon (right, Fig. 22) and the ten-step 1-mm (0.1 mm per step) fixed etalons especially useful.

The five-step 5-cm etalon consists of six, 9/32-in.-thick, precision parallel glass plates clamped in an L-shaped cradle on a baseplate, with the front reflecting faces finely polished and located exactly parallel with each other (as checked with an interferometer). Each of the faces is located exactly 1 cm behind the preceding face. Adjusting screws and springs hold the plates in position, yet permit easy adjustment of plate positions.

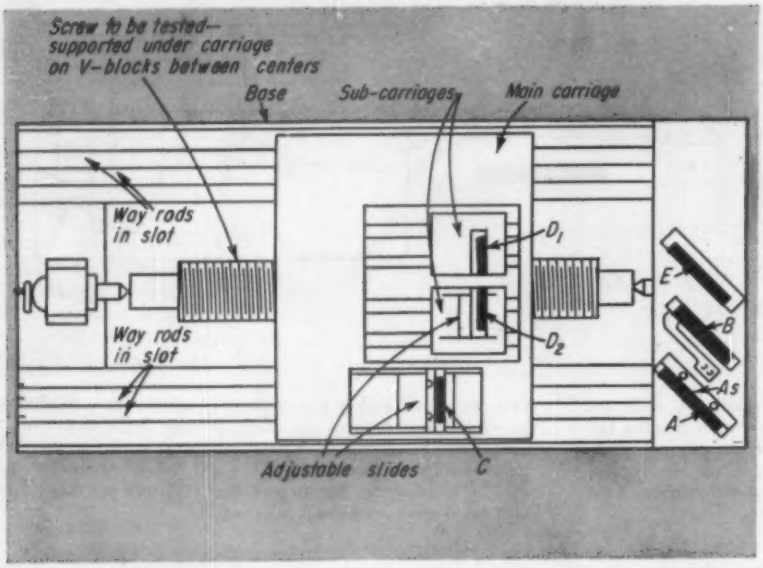
The ten-step 1-mm etalon is similarly constructed. It has eleven, 5/32-in.-thick glass plates with successive reflecting faces each positioned precisely 0.1 mm behind the one preceding it. In both cases the parallel reflecting faces must be normal to the axis of the D leg of the interferometer when the etalon is in position.

DEFINITIONS

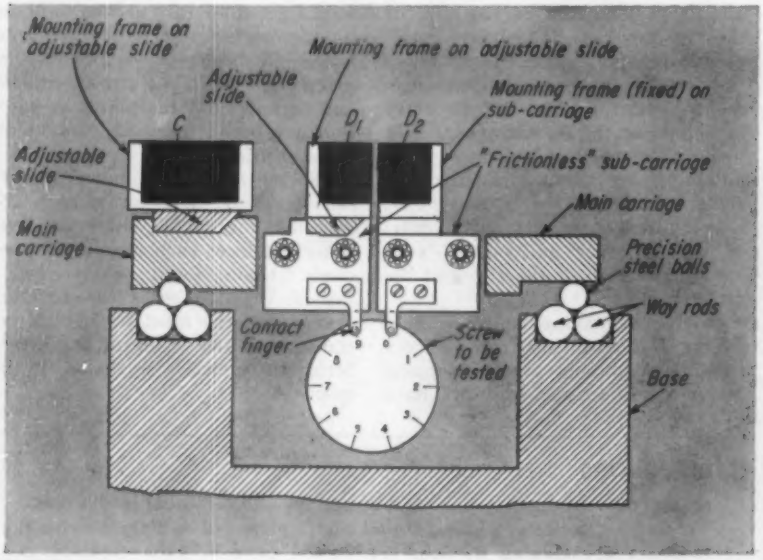
ECHELON—*An apparatus of high dispersive and resolving power made up of a series of plane parallel plates arranged so that the edges, each overlapping its neighbor by the same amount, resemble a flight of stairs. Plates are the same thickness and are usually of glass.*

ETALON—*One of the rods used to keep the plates of an interferometer at a fixed distance apart. Or, an interferometer having plates a fixed distance apart.*

Interferometer setups for checking precision screws



23. Screw-thread interferometer, an O'Donnell modification of the Michelson parallel interferometer, checks periodic and run error on precision leadscrews. Fixed optical elements *A*, *B*, and *E* are positioned on a bridge across one end of the base. Mirror *C* is adjustably positioned on the main slide, which also carries mirrors D_1 and D_2 on independent sub-carriages. The *C* and *D* mirrors advance equally when the screw is turned if the threads are perfect; if there are lead or drunkenness errors the mirrors move out of alignment. Similar setups can be arranged to check screws for a wide variety of precision devices



24. Main carriage and sub-carriages of the screw-thread interferometer run on ball-bearings ways to insure free, smooth movement when the turning screw advances all three carriages simultaneously. White-light fringes check errors. Each sub-carriage has a contact finger that is positioned into the screw thread. For periodic error tests the fingers are entered into the same thread, and are spaced 0.1 revolution apart; for error of run tests, the fingers are replaced with another set, and the screw is contacted a selected number of threads apart

The Michelson parallel interferometer has been modified as the O'Donnell split-*D*-plate dynamic white-light interferometer for precise measurement of pitch and drunkenness errors in precision leadscrews of any size or length. Only one screw is used—the one being tested.

In the setup for checking the ruling engine leadscrew (Fig. 23, 24, 25), a main carriage supporting both the *C* and the split *D* mirror assemblies of the interferometer was mounted on bearing ball and precision steel rod frictionless ways so backlash and stick-slip problems would not interfere with the accuracy of measurements. This main carriage was connected with the screw to be tested by a split nut, so mirror *C* would be advanced with the pitch of the screw as it was rotated.

Mirrors D_1 and D_2 are mounted on sub-carriages mounted with frictionless ball sleeve bearings on parallel, horizontal guide rods within a cutout opening in the main slide. Each of these sub-carriages has a contact finger that is positioned into the screw thread, with the two contact points 0.1 revolution apart, so mirrors D_1 and D_2 are exactly in the same plane when the thread surface is part of a perfect helix.

When the screw is turned slowly the independently mounted *C*, D_1 and D_2 mirrors will advance at the same rate and the white-light fringes shown by this interferometer will not be disturbed. However, when the screw is imperfect the relationship of the three mirrors will change with the drunkenness of the thread. Mirrors D_1 and D_2 will shift forward and backward out of the normal plane and the white-light fringes they reflect will remain horizontal but will move up and down out of line with each other. There also will be a shift due to imperfect motion of the main carriage caused by imperfections in the portion of the thread covered by the split nut.

Error tests

For periodic error tests, the contact fingers are entered into the same thread, and are spaced 0.1 revolution apart. For error of run determinations, the fingers are replaced with another set, one somewhat longer than the other, so the screw will be contacted a selected number of threads apart, and along the same longitudinal plane, while keeping the *D* mirrors in line. When checking ruling engine screws, we positioned the fingers 1, 5 and 20 threads

apart—using a different set of contact fingers each time—for different series of readings. Using greater spacings eliminates accumulation of errors which might develop from shorter spacings.

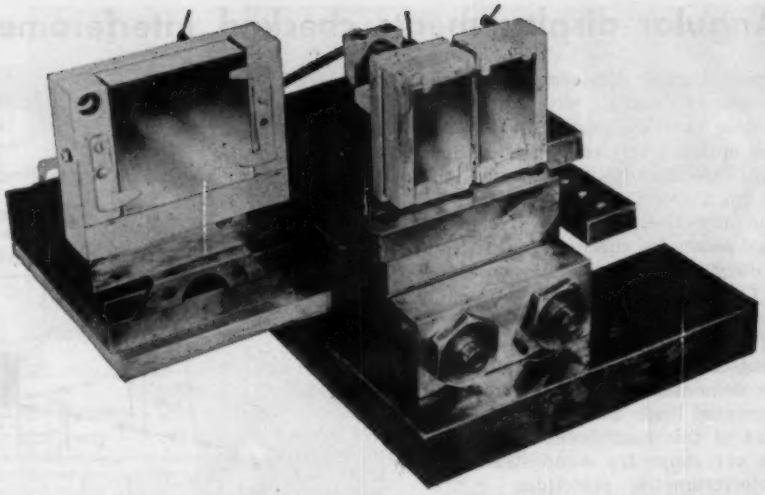
Breadboard design

In a more recent setup for checking pitch errors on precision screws, a combination of the O'Donnell split-plate and the Michelson parallel interferometer was assembled in breadboard fashion on a large steel surface plate (Fig. 26, 27). This type of construction is entirely adequate for precision interferometers, takes less time to complete, and costs less than conventional instruments.

Arranged to check pitch errors on screws with up to 6-in. thread length, this interferometer uses only conventional *C* and *D* back mirrors, with each of these mirrors mounted on a ball-supported slide having a thread-contact roll on an arm extended from the side of the slide base. The instrument could easily have been extended for screws of any length.

The *A*, *B* and *E* members of the optical system are fixed to a bridge across one end of the surface plate, and for convenience are located at the end opposite the operator's position. Therefore, the operator observes interference fringes through a telescope and a separately mounted mirror.

The screw to be tested is supported in precision V-blocks and is turned slowly by hand. Slides carrying *C* and *D* mirrors are supported on bar and ball ways, one on each side of the screw. These ways are aligned exactly parallel with the screw-support V-blocks.

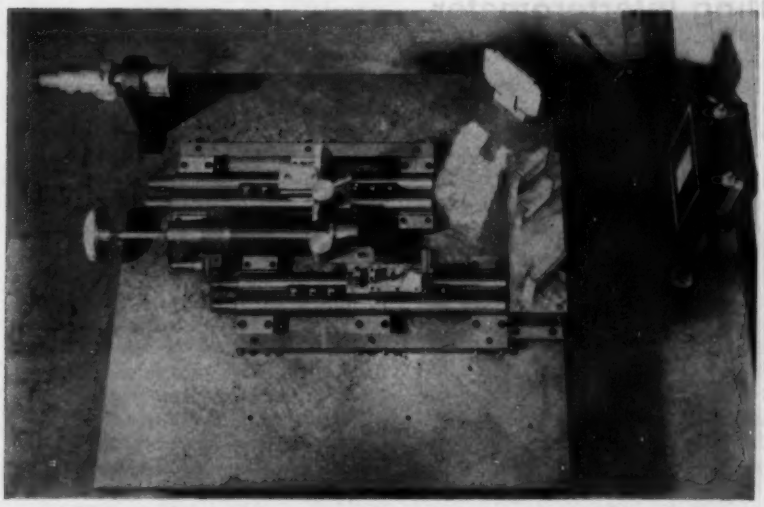


25. Mirrors on main and auxiliary slides of screw-thread interferometer are held in place by leaf springs. Mirror *C* is on an adjustable slide so it can be aligned precisely with the two *D* mirrors at the beginning of a test run. Each mirror is adjustable in its frame

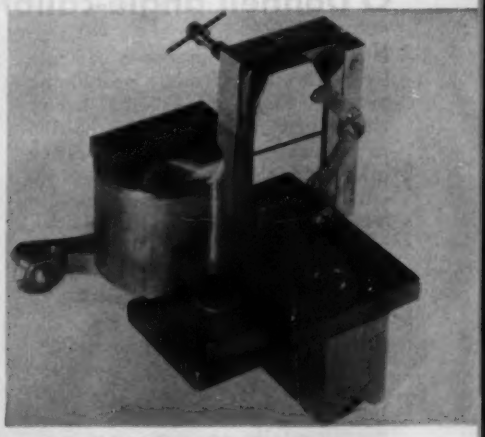
Each mirror slide has a contact-roll support arm extending from one side, and the mirrors are so positioned that when the contact rolls are in place in the screw threads and spaced the desired number of threads apart, the optical paths *C* and *D* will be exactly equal so long as the pitch remains accurate.

Under perfect conditions, the central white-light centering fringe on the *D* mirror will remain centered on a fiducial mark reflected from the *C* mirror. Any movement of the central white-light fringe up or down from the fiducial mark indicates lengthening or shortening of the thread helix as the slides progress along the screw.

Inaccuracies can be checked to within 0.1 of a monochromatic fringe (approximately one millionth of an inch) with this instrument—or to approximately 0.05 of an interference fringe when a vernier is inserted in the objective of the viewing telescope. For a permanent record of inaccuracies in the screw, a camera can be mounted in place of the telescope, with a counter positioned in its field of view to show the position of each measurement.



26. Pitch errors on precision screws can be checked on this breadboard setup of a combination O'Donnell split-plate and Michelson parallel interferometer. Perfectly straight 1¼-in.-dia steel rods and ¾-in.-dia bearing balls form the frictionless ways on which mirror carriages are supported. Instrument can be made to almost any length



27. Mirror carriages for thread interferometer (Fig. 26) have thread contact rolls on side arms, and weights to keep these rolls in firm contact with the screw threads. The *C* mirror, shown, has fiducial mark thread across center of its face

Angular displacements checked interferometrically

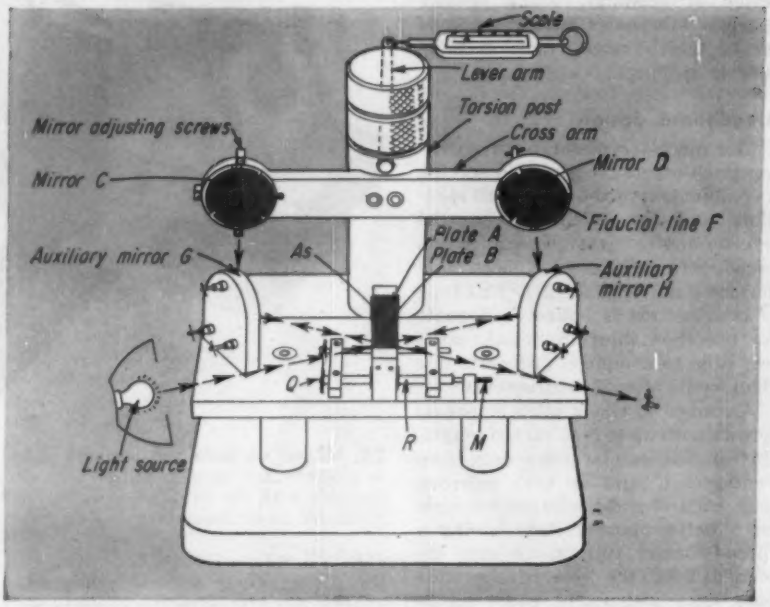
Small angular displacements can be measured easily with relatively simple modifications of the Michelson optical interference circuit. Such units are already in regular use here at the University of Chicago, and in the inspection rooms of two machine-tool plants for checking indexing accuracy of precision rotary tables.

One of the first interferometers for checking angular displacements probably was the torsional interferometer devised by Prof Michelson to demonstrate the effect of small torsional loads on steel rods. A replica of this instrument (Fig. 28) is in our shops for demonstrations of interferometric principles.

In this instrument, a 4-in.-dia torsion post 12 in. long is set vertically on a heavy steel base. A cross arm, approximately 8 in. above the base, supports back mirrors *C* and *D* on 13-in. centers, with their reflecting faces in the same vertical plane.

Dividing and compensating plates *A* and *B* are coupled together face-to-face in the same frame, with the beam-splitting and recombining face *As* of plate *A* in optical contact with the inner face of plate *B*.

Mirrors *G* and *H* are positioned to direct the split light beams normally to the *C* and *D* mirrors, and to return their reflections to the recombining surface *As*. The combination *A-B* plate is carried by slide rod *R* for adjustment with screw *M* and leaf spring *Q* to equalize optical legs *C* and *D* of the interferometer.



28. Michelson torsional interferometer—Fingertip pressure applied to turn torsion rod is sufficient to shift the white-light interference fringes away from a fiducial line as the observer watches through beam-splitter. Auxiliary mirrors serve to turn optical legs of Michelson interference system so light beams passing to and from *C* and *D* will pass through plates *A* and *B*

Fiducial line *F* across the face of mirror *D* provides means for measuring displacement of light fringes as the torsion post is twisted. When twisting torque is applied, the *C* and *D* mirrors swing to lengthen one optical leg and to shorten the other. Thereupon, the white-light fringes will move up or down, away from the fiducial position an amount measured in numbers of fringes displaced proportional to the angular displacement of the post and its mirrors.

O'Donnell angle-calibrating interferometer

Need for greater precision in angular calibration of angle positioning devices, toolroom dividing heads, and rotary tables has led to the development of an angle-calibrating interferometer (Fig. 29) which, in one arrangement, is accurate to within 0.1 sec of arc, and in another, with sensitive corrective plate control, is accurate to within 0.05 to 0.10 sec of arc depending on operator skill and ambient conditions.

In principle, this O'Donnell angle-calibrating interferometer resembles the older Michelson white-light linear-step interferometer. It is fundamentally an *angle step comparator*, whereas the white-light step mirror interferometer is a *linear step comparator*. In both instruments an arbitrary step (an angle in one case, a length in the other) is used as the fiducial reference unit to which successive displacements of the device being calibrated are compared. In each case these arbitrary steps can be reduced to absolute angles or lengths within the instrument itself as calibration proceeds.

In the angle-calibrating interferometer exact distances are not involved, since a unit of angular displacement instead of linear displacement is used as the reference unit, so white-light fringes are not necessary. Circular monochromatic fringes from a mercury lamp (Hg^{198}) are used for measuring the difference in angular displacements. This simplifies the observer's problems.

The interferometer is laid out on a large steel surface plate, usually mounted on a welded steel table set up on vibration dampeners. Since the two beams of the interferometer must be approximately 5 in. wide for an interferometer accurate to 0.1 sec of arc, or 11 in. wide for one accurate to 0.05 sec of arc, the angle between the two crossing beams is made 135° instead of the 90° displacement used in the Michelson interferometers.

Dividing and compensating plates *A* and *B* are quite large, measuring 15 mm thick, 60 mm high, and 140 mm wide for the instrument accurate to 0.1 sec of arc, or 330 mm wide for one accurate to 0.05 sec of arc. Plate *B* is mounted on the *As* side of plate *A* and close to back mirror *C* so it will not obstruct the interferometer's incoming beam of light. In some cases (Fig. 29) both *A* and *B* plates are mounted in fixed frames. In others, plate *B* is set in a spring base so it can be slightly reoriented during calibration for zeroing and

making fractional fringe determinations.

Optical members *A*, *B* and *C* make up the interference optics of the universal member of the interferometer. The angularly adjustable D_1D_2 step mirror member (Fig. 30) mounted on the table to be calibrated completes the basic Michelson system.

Essentially, the D_1D_2 step mirror assembly is used with the rotary table's own indexing mechanism to step off angular displacements as the table is rotated. For each index, the displacement steps are compared to the fixed D_1D_2 displacement in terms of circular fringes. If the average residual error of the steps amounts to more than three fringes after several error determinations, displacement between D_1 and D_2 should be reset and calibration repeated.

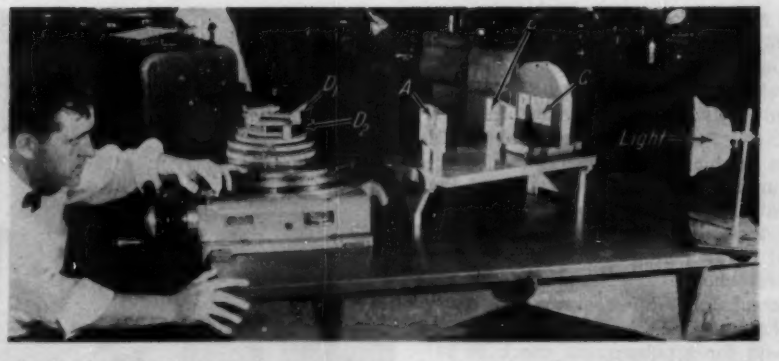
The angular magnitudes used in calibrating a particular instrument depend upon what is required of that instrument. In some cases the angular steps may be as much as 90° or 120°, in other steps may be as small as 1° to 2°.

In effect, the O'Donnell angle-calibrating interferometer can be likened to a pair of draftsman's dividers employed to step off chords when dividing the periphery of a circle into a specified number of equal arcs. The difference, of course, is the unit of measurement employed —chords in one case, angular steps in the other. In both cases the method is self-checking when the circle is closed and the amount of accumulated error noted.

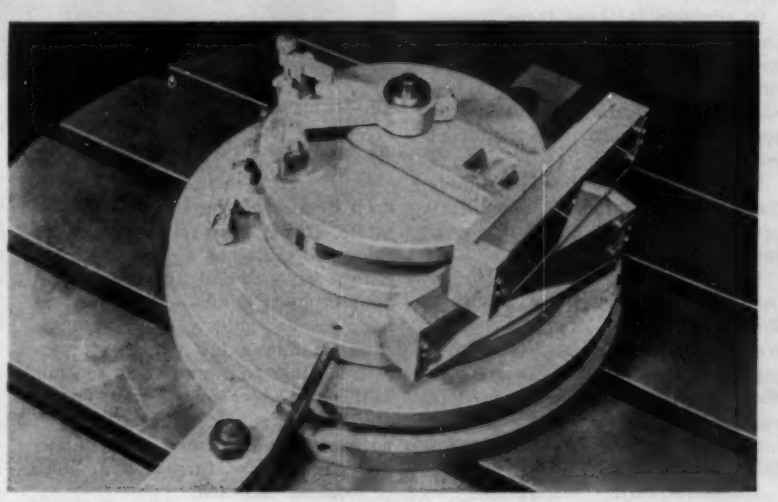
Two makers of precision rotary tables for jig borers and similar toolroom equipment, and for inspection operations, have constructed and installed in their inspection departments instruments based on the O'Donnell angle-measuring interferometer. In both cases, these instruments are accurate to 0.1 sec of arc.

First to adapt the O'Donnell angle-measuring setup to industrial calibration of precision rotary and indexing tables was Moore Special Tool Co, Bridgeport, Conn. Their angle-measuring interferometer (Fig. 31) is mounted on a heavy surface plate in an air-conditioned inspection room. Concrete piers supporting the table extend to hardpan, 16 ft below ground level, to minimize disturbances caused by vibration.

Because it is responsive to stray air currents and sound waves, the Moore interferometer is further isolated in a Plexiglas housing (not shown in the photograph).



29. Angle-calibrating interferometer is set up to check index tables within ±0.1 sec of arc. Dividing plate *A* and compensating plate *B* are mounted in fixed frames. Back mirror *C* and adjustable step mirrors D_1 and D_2 complete the basic Michelson interference system. In some setups plate *B* is set in an adjustable base that can be shifted slightly for making fractional fringe determinations



30. Step mirror assembly is used in conjunction with the rotary table's own indexing mechanism to step off angular displacements as table is rotated. Each mirror has coarse and fine adjustments so their relationship can be precisely corrected

31. Interferometric angle comparator permits Moore Special Tool Co to guarantee that its Ultra Precise rotary tables have an overall performance accuracy within two seconds of arc throughout 360° of rotation. This is confirmed by a calibration chart supplied to the customer

Each Moore No. 2 rotary table shipped to a customer is accompanied by a polar calibration chart developed by checking that table at 2° intervals with the interferometer. Each of these tables is guaranteed to have an overall performance accuracy of ±6 sec arc throughout the entire 360° of rotation.

To avoid possible accumulations of reading errors, Moore inspectors first check each table at four 90° intervals. Values obtained during the first check are used as base numbers for a subsequent check at 18° intervals, and these in turn form the basis for a check at 2° intervals. The circle is closed during each of these checks, to reveal any errors in mirror settings.

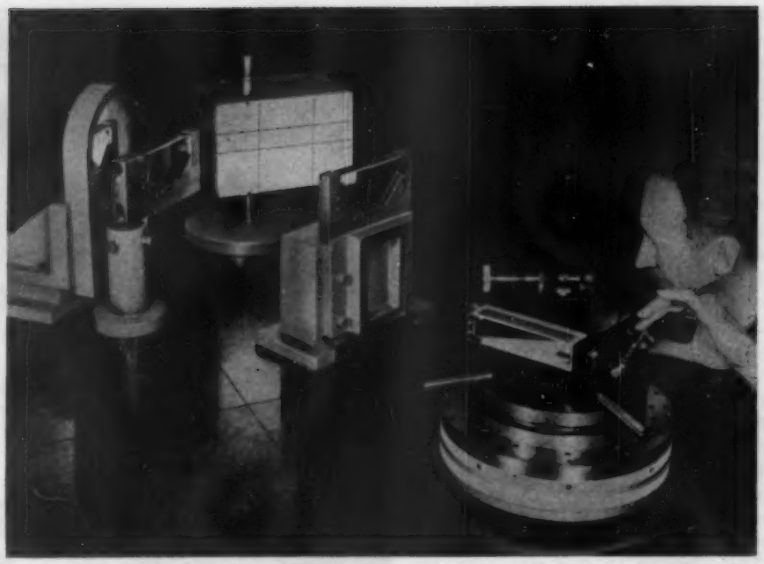
In addition to these three inspection cycles, Moore Ultra Precise rotary tables are calibrated throughout their entire 360° range, including minutes and seconds of arc, and are guaranteed to be accurate within ±2 sec of arc.

Where necessary, the Moore interferometer can be used to calibrate precision index tables to within 0.1 sec of arc.

Each Ultradex precision indexing table marketed by Michigan Tool Co, Detroit, Mich, is checked with a specially designed O'Donnell-type angle-calibrating interferometer (Fig. 32) in a vibration, temperature and humidity-controlled inspection room. Temperature is held to within ¼°F.

Interferometric calibrations of Ultradex tables have been made for each degree of the full 360° of rotation. Inspection procedures insure that each table has a positioning accuracy of ¼ sec of arc or less. An adapter plate is available for indexing these tables in increments smaller than a full degree—it permits settings to minutes and seconds within one second of arc, using standard gage blocks of Class AA accuracy supplemented with 19 special gage blocks furnished in steps of 0.000,005 in. each.

There are two horizontal and two vertical fiducial lines on the screen in front of the monochromatic light source used with Michigan Tool Co's interferometer. When the inspector is calibrating an Ultradex table, he follows the upper horizontal line for the upper mirror of the D_1D_2 assembly, and the lower horizontal line for the bottom mirror. The vertical fiducial lines are placed so that one fringe change, when sweeping from one to the other, equals ½ sec of arc. This amount to 1/2,592,000 part of a circle.



32. Michigan Tool Co built this O'Donnell-type angle-calibrating interferometer to calibrate their 12-in.-dia Ultradex rotary index tables. Interferometric calibrations are made for each degree of the full 360°

Light sources for interferometers

Several factors must be considered when you choose a light source for use with an interferometer. Ready availability at a reasonable price is important. The light must be easy to use, be of the proper intensity, and produce narrow, suitably distributed lines in the spectrum.

Where the path difference between the two interfering beams of light varies from zero to only a few wavelengths in a division-of-amplitude interferometer, ordinary white light —such as obtained from the sun, or from a 60- or 75-watt frosted incandescent light bulb—can be used satisfactorily. If a highly intense and concentrated white-light source is needed, the 2-watt "Zirconarc" originally developed by Western Union Co works very well. The luminous spot emitted by the concentrated arc of this lamp is only 0.003 in. dia.

For most interference setups, however, monochromatic light sources should, or must, be used. While there are no sources which emit only one color, or wavelength, of light, there are a number of electric discharge lamps which emit light with a relatively limited number of radiations, each of a specific wavelength.

For a number of interferometric applications I have successfully used either the low-pressure Cooper Hewitt mercury-vapor lamp or the mercury germicidal lamp commonly used for sterilizing chicken houses. This latter source can be used safely as a monochromatic light source for many interferometers if a pane of window glass is used as a shield to hold back the actinic radiations, while allowing visible spectral lines to pass through.

Standard source for critical interferometric measurements has for years been the red line of cadmium. The Michelson-type lamp adopted as standard in 1935 by the International Congress on Weights and Measures emits a primary red line with a wavelength of 6438.4696 Angstrom units in normal air (15°C, 760-mm Hg atmospheric pressure, 0-mm water vapor pressure).

In recent years two other light sources, the mercury-198 and the krypton-86, have become popular and are widely used, even for some very demanding applications. In fact, at a meeting in October 1958 the International Committee on Weights and Measures agreed to recommend to the General Conference on Weights and Measures, which meets this year, that the meter be defined in terms of the orange line of krypton-86.

Wavelengths of visible monochromatic radiations

Material radiated by light source	Angstrom units (0.000,000,1 mm)	Microns (0.001 millimeter)	Microinches (0.000,001 inch) (1 in. = 25.4 mm)
Cadmium			
• Red Line	6438.5	0.643,850,37	25.348,439,8
Green Line	5085.8	0.508,584,83	20.023,024,8
Blue Line	4799.9	0.479,993,60	18.897,385,8
Violet Line	4678.2	0.467,817,43	18.418,009,0
Mercury 198			
Yellow 1 Line	5790.7	0.579,069,31	22,798,004,6
Yellow 2 Line	5769.6	0.576,962,87	22.715,073,6
• Green Line	5460.8	0.546,078,20	21,499,141,7
Violet Line	4358.4	0.435,836,06	17.158,900,0
Krypton 86			
Red Line	6456.3	0.645,632,36	25.418,596,8
• Orange-Red Line	6056.2	0.605,615,88	23.843,144,8
Yellow Line	5870.9	0.587,094,66	23.113,963,0
Yellow-Green Line	5649.6	0.564,959,17	22.242,487,0
Helium			
Red Line	6678.2	0.667,818,4	26.292,062
Yellow Line	5875.6	0.587,564,9	23.132,476,3
Green Line	5015.7	0.501,570,2	19.746,858
Blue-Green Line	4921.9	0.492,195,5	19.377,776
Blue Line	4713.1	0.471,316,8	18,555,780
Violet Line	4471.5	0.447,150,1	17.604,334
Thallium			
Blue-Green Line	5350.0		

Notes: Values shown are for lamps now most commonly used for interferometric studies, as determined spectroscopically by the National Bureau of Standards, Washington, D C (except for Krypton 86 and Thallium, which were obtained from other sources), under "standard air" conditions: 20° C ambient temperature, 760 mm Hg atmospheric pressure, 10 mm water vapor pressure, 0.03% carbon dioxide in atmosphere. The three lines identified with black dots are those now generally accepted as standard for precise laboratory work with interferometers. The red line of cadmium was the one selected by Michelson and others when measuring the length of the International Meter in terms of light waves—and the one adopted in 1935 as the standard line for light wave measurements by the International Congress of Weights and Measures, which body wrote specifications for a cadmium lamp emitting a red line wavelength of 6438.4696 Angstrom units. Values for mercury-isotope 198 are for lines emitted by an electrodeless lamp with 3 mm argon pressure. The yellow line of helium (wavelength 5875.6 A) is the monochromatic light now most generally used with optical flats for shop inspection operations.

The thallium-vapor laboratory lamp made by The General Electric Co Ltd in England produces an intense source of pure 5350 Angstrom units of monochromatic illumination. Approximately 99.5% of its light goes into the 5350 A line, and this spectral line is free from satellites which often limit the use of mercury lamps in interferometry. The visibility curve of this lamp is good and clear over a path distance of 30 mm without filters.

Helium-vapor lamps are generally used in metalworking plants for work with optical flats, and often are used for absolute measurement of lengths up to 1 in.

Wavelength data for monochromatic light sources most frequently used for interferometry today are given in an accompanying table.

Of importance is the fact that in some instances two monochromatic radiations can be used simultaneously to advantage. For some path differences, the bright and dark fringes of one radiation for a given source will coincide with the bright and dark fringes of the other, respectively, resulting in clear, visible fringes. Then, if the path difference is increased sufficiently, the dark fringes of one will coincide with the bright fringes of the other and the field will appear uniformly illuminated with faint indistinct fringes if the intensities of the two fringe systems are equal and if they are nearly the same color. With slight change in color, faint, nearly invisible fringes are produced with near zero visibility; with different colored radiations the fringes appear bright and are alternately one color and the other. Since the two radiations have no set phase relationship, there will be no observable interference between their waves.

In any interferometric setup, intensity of the light source must not be too great. A light wedge should be used to shield the observer's eyes when intense light sources make fringe recognition difficult. Also, if in a Michelson interferometer setup the beam splitting surface *As* splits the beam 40% and 60% instead of 50% and 50%, difficulty may be experienced in seeing the interference fringes because of differences in light intensity between the two optical paths.

Accuracy of interferometric measurements

Interferometers are, in almost all cases, sensitive to vibration, including sound. If the amplitude of vibration in one of the optical members of an interferometer reaches a twentieth of a lightwave, the fringes will become blurry; if it increases to one quarter of a lightwave, the fringes will disappear. So, wherever possible, the precision interferometer should be set up in a vibration-free, sound-proofed room. However, in many instances satisfactory results can be obtained with well-designed, sturdily constructed interferometers out in the shop, if noise levels are not high, and the tables supporting them are of heavy section to dampen vibrations and are mounted on vibration-dampening pads.

Atmospheric conditions — particularly changes in atmospheric pressure—can also influence the accuracy of interferometric measurements.

During a talk at a meeting of the American Ordnance Association's Dimensional Standards and Metrology Div on January 12, 1955, Irvine C Gardner, then chief of the Optics and Metrology Div of the National Bureau of Standards, cited the following data when discussing problems involved in certifying measurements of gage blocks to one ten-millionth of an inch with interferometers:

1. When measured in a vacuum, a 1-in. steel gage block will be 3 ten-millionths of an inch longer than when measured in a normal atmosphere.

2. A change in temperature of 0.008° C will cause a change of 1 ten-millionth of an inch in a 1-in. steel gage block.

3. The average wringing interval when a gage block is wrung to a smooth baseplate is 3 ten-millionths of an inch. The gage length is defined as the geometric length of the block plus one wringing interval.

4. When measuring a metal gage block interferometrically the light acts as though it penetrates the gage. This is due to what is called the change of phase that accompanies reflection at the surface of a light-absorbing material. The difference in change of phase between light reflected from the polished surface of a gage block and that reflected from a glass or quartz baseplate upon which the gage block is wrung makes necessary a correction of 3 ten-millionths of an inch in the observed length of the block. In general, the practical length of a gage block checked with an interferometer is its geometrical length, plus one wringing film, plus the difference in phase penetration occurring at the gage surface and the wringing plate surface.

5. When a block is positioned for an interferometric measurement, if the rays of light are inclined from the normal axis 100 sec of arc, an error of 1 ten-millionth of an inch will be introduced per inch of gage block length.

6. The index of refraction of air changes with changes in barometric pressure. An error of 0.25 mm in measuring the height of the mercury column of a barometer can result in an error of 1 ten-millionth of an inch per inch in the final interferometric measurement of the length of a gage block.

7. An uncertainty of 2° C in the temperature of the mercury in the barometer could introduce an error of 1 ten-millionth in./in. of gage length.

8. An error of 0.3 cm/sec/sec in determining the correction of the height of the mercury column in the barometer for departure from the standard value of acceleration due to gravity can introduce an error of 1 ten-millionth in./in. of gage length.

9. An error of 0.1° C in determining the temperature of the air surrounding the interferometer can introduce an error of 1 ten-millionth in./in. of gage length.

10. If a gage block measures 4 in. long when lying on its side, it will shorten 0.8 ten-millionths of an inch if supported on its lower end, or lengthen the same amount if suspended from its upper end. This elongation or shortening varies as the square of the length of the gage block.

In addition, presence of only small percentages of carbon dioxide in the atmosphere can measurably affect the accuracy of linear measurements made with even the most precise interferometer.

DEFINITIONS

BEAM—*A collection of pencils of light originating at an extended or broad source on many luminous points. The term parallel beam is a misnomer but it is used to define an approximately parallel collection of pencils of light. The rays of each individual pencil are parallel with each other, but the pencils are not parallel because they originate at displaced portions in the extended light source. These pencils are approximately parallel if the intense source of light is small, such as the carbon arc of a long focal length searchlight.*

PENCIL—*A narrow, aggregate system of rays originating at a single point source of light as a diverging conical pencil. This pencil can, by reflection or refraction, be changed to a bundle of parallel rays or to a converging pencil where the rays meet at a point.*

RAY—*One of the lines of light which appear to radiate from a bright source of light. It is a simple, geometrical line representation of the direction of travel of a quantum of light, that paradoxical energy nature of a wave train that cannot be divided, but is divided in interferometry.*

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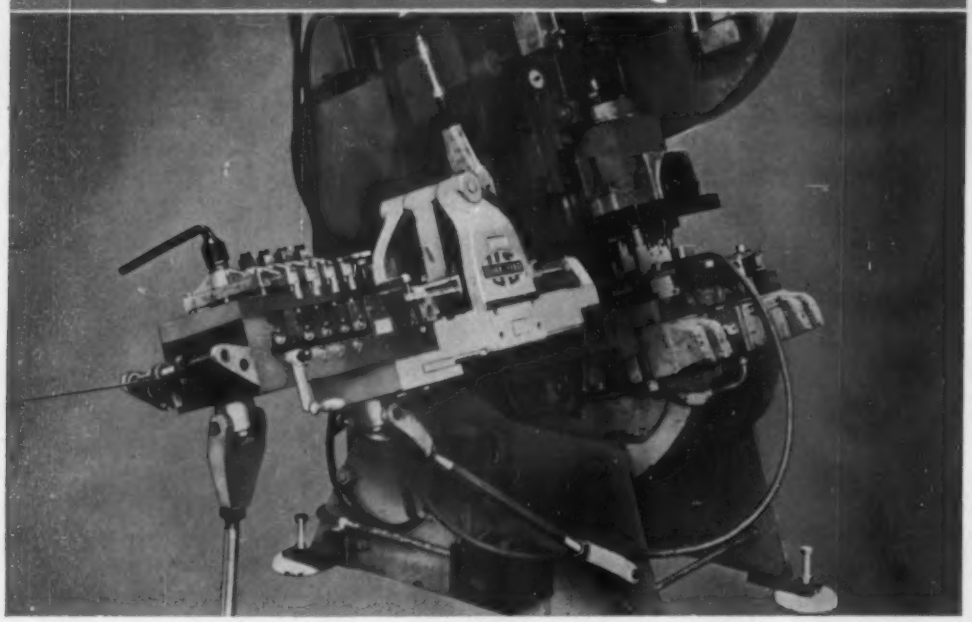
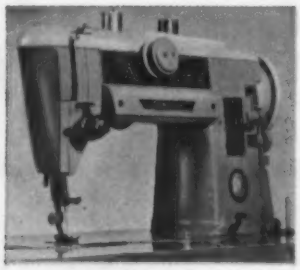


U. S. Slide Feed, Model SF-68A and U. S. Plain Stock Straightener, Model SS-68A, in action at Elizabethport plant of The Singer Manufacturing Company.



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Machining Cobalt Alloys—IV

Turning and Facing

Turning and facing are the easiest machining operations to perform on the cobalt-containing alloys. High-speed steel, nonferrous cast alloy, and carbide tools are used. In the case of high-speed steels, a cobalt grade like T6, T8, or M30 is recommended. For intermittent cuts, high-vanadium high-speed steel and reduced speeds should be used. Cutting tools should be replaced before they become dull. A flank wear of 0.010 to 0.015 in. should be maximum, to avoid work hardening. Recommended tool geometries for the above tool materials are contained in Table 4.

Work should be rigidly supported and a positive feed should be maintained during cutting. When finishing cuts are necessary, the depth of cut should be below the work-hardened surface left by the roughing operation. Stress relieving is sometimes required after roughing operations.

Cutting speeds greater than those shown in Table 6 are sometimes used and shorter tool life is accepted to obtain a reasonable production rate. When turning scaled work, lower cutting speeds should be used. Feed rates below 0.0035 ipr tend to burnish the work surface.

Tapping

Cobalt-containing alloys are most easily tapped in the solution-treated condition. However, design requirements or a particular sequence of operations may dictate tapping in the annealed or aged condition. Plenty of chip room is usually required during tapping. Hence, three-flute, high-speed-steel gun taps have been used and seem superior to the four-flute types. The hook angle should be somewhat greater than that used for tapping the more common metals. Special surface treatments applied to taps increase resistance to abrasion. Hand tapping is used, rotating the tap half a revolution before reversing. A sulfochlorinated type of oil is applied with a brush. If possible, design parts utilizing a 60% thread.

TABLE 4—TOOL MATERIAL AND GEOMETRY

TOOL MATERIAL	GEOMETRY	TOOL ANGLES, DEGREES						NOSE RADIUS, inch	CHIP BREAKER
		RAKE		RELIEF		CUTTING EDGE			
		Back	Side	Side	End	Side	End		
Cobalt types of high-speed steels	A	8-12	6-8	5-8	7-10	10-15	10-15	—	—
	B	7-10	5-8	5-8	7-10	10-15	10-15	—	—
	C	5-8	5-8	5-8	7-9	10-15	8-15	—	Yes
	D	7-10	5-8	7-10	7-10	10-15	8-15	—	—
	E	0-8	8	4-5	4-5	15-30	10-15	1/32-1/16	—
	F	0-8	8-15	4-5	4-5	15-25	10-20	1/32-3/32	Yes
	G	5-10	5-10	5-8	7-10	10-15	10-15	—	Yes
	H	7-10	5-10	5-8	7-10	10-15	10-15	—	—
	I	4-6	4-6	4-6	4-6	—	—	—	—
	J	4-6	15-20	4-8	3-5	8-12	8-12		—
Cast alloy	F	0-8	8-15	4-5	4-5	15-25	10-20	1/32-3/32	—
	K	5-10	5-8	5-8	7-10	10-15	8-15	—	—
Carbide grades C-1 to C-8 inclusive	L	0-3	6	6	6	0	6	0.02	—
	M	0-3	6	7	7	45	—	—	—
	N	0-8	8-15	4-5	4-5	15-25	10-20	1/32	Yes
	O	5-8	8-10	5-7	5-7	15-30	—	1/32-1/16	—
	P	15	10-15	6	6	—	—	—	—
	Q	—6	9	6	6	30	9	—	—
	R	—2	6	6	6	8-12	8-12	1/32-1/16	—
	S	8-12	4-7	3-6	3-6	6-10	4-8	1/32-1/16	—

TABLE 5—MACHINABILITY INDEX AND HORSEPOWER REQUIRED AT THE CUTTING POINT

GROUP	METAL	INDEX, % of B-1112	HORSEPOWER hp/in.^{3}/min
Steel	B-1112(st,)	100	0.81-0.90
Stainless st,	302	35	0.97-1.35
Titanium	Commercially pure and alloys	—	1.20
High-speed steels	M15	33	—
	M30	33	—
	M36	33	—
	T15	25	—
Super alloys	Refractaloy	20	1.30
	N-155	15	—
	HS-25	12	—
	Nimonic 90	10	1.30
	S-816	9	1.25
	J-1570	9	1.30
	K-42-B	8	—
	Inconel 700	8	1.40
	HS-31	6	—
	HS-21	6	—

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TABLE 6—TURNING COBALT-CONTAINING ALLOYS[a]—*Continued on page 153*

ALLOY DESIGNATION	CONDITION[b]	TOOL MATERIAL[c]	DESIGN[d]	MACHINING OPERATION						CUTTING FLUID
				ROUGH			FINISH			
				Speed, fpm	Feed, ipr	Depth of Cut, inch	Speed, fpm	Feed, ipr	Depth of Cut, inch	
Therlo Rodar Kovar A										Use lard oil for fine finish work
Konal		Carbide		100-175	0.015-0.025					
G. 188[e]	Aged	HSS	I	30-40	0.002-0.02	0.005-0.035				Soluble oil, 15:1
		Carbide	P	150-175	0.01 -0.02	0.125-0.75				
Refractaloy[f] 26, 70, 80 K-42-B[g]	Solution treated	HSS	G	40-65	0.003-0.008	0.031				Sulfochlorinated oils
		Carbide	M; N; O	67-105	0.008-0.013	0.05				
	Aged	Carbide	M; L				75-120	0.006-0.01	0.011-0.015	
N-155 S-590	Aged	HSS	C	18-20	0.007-0.011	0.025-0.045	18-20	0.003-0.008	0.008-0.011	Sulfochlorinated oils
		CA	K	20-40	0.007-0.011	0.025-0.045	20-40	0.003-0.008	0.008-0.011	
Hastelloy X	Sol. tr.	Carbide	O	50-72	0.008-0.013	0.05 -0.1	68-90	0.006-0.009	0.011-0.015	
Nivco-10 Inconel-X Nimonic 90 Inconel 700[f] Udimet 500[h] Udimet 700 M-252 Waspalloy	Solution treated	HSS	F	20-35	0.015	0.093 max				Heavy sulfur base or sulfochlorinated oils
		CA	F	40	0.015-0.025	0.25 max				
		Carbide	M; N; O	30-45	0.008-0.013	< 0.093				
	Aged	HSS	F	10-20	0.015	0.093 max	—	—	—	
		Carbide	N	60	0.008-0.018	0.187 max	75-125	0.005-0.010	0.015-0.046	
		Carbide	N				30-50	0.003-0.008	0.015-0.046	
HA-25	Sol. tr.	HSS	E or F	25	0.009	0.062	—	—	—	Soluble oil and lubricant
		Carbide	N or O	35-55	0.01 -0.015		45-55	0.006-0.01		
		Carbide	N or O	30-45	0.009-0.015	0.06 -0.1	30-45	0.003-0.005	0.008-0.01	
J-1570[e] René 41	Aged	Carbide	M; N; O	35-55	0.010-0.015	0.063-0.125	35-47	0.004-0.009	0.031	
				30-40	0.008-0.013		50-60	0.005		

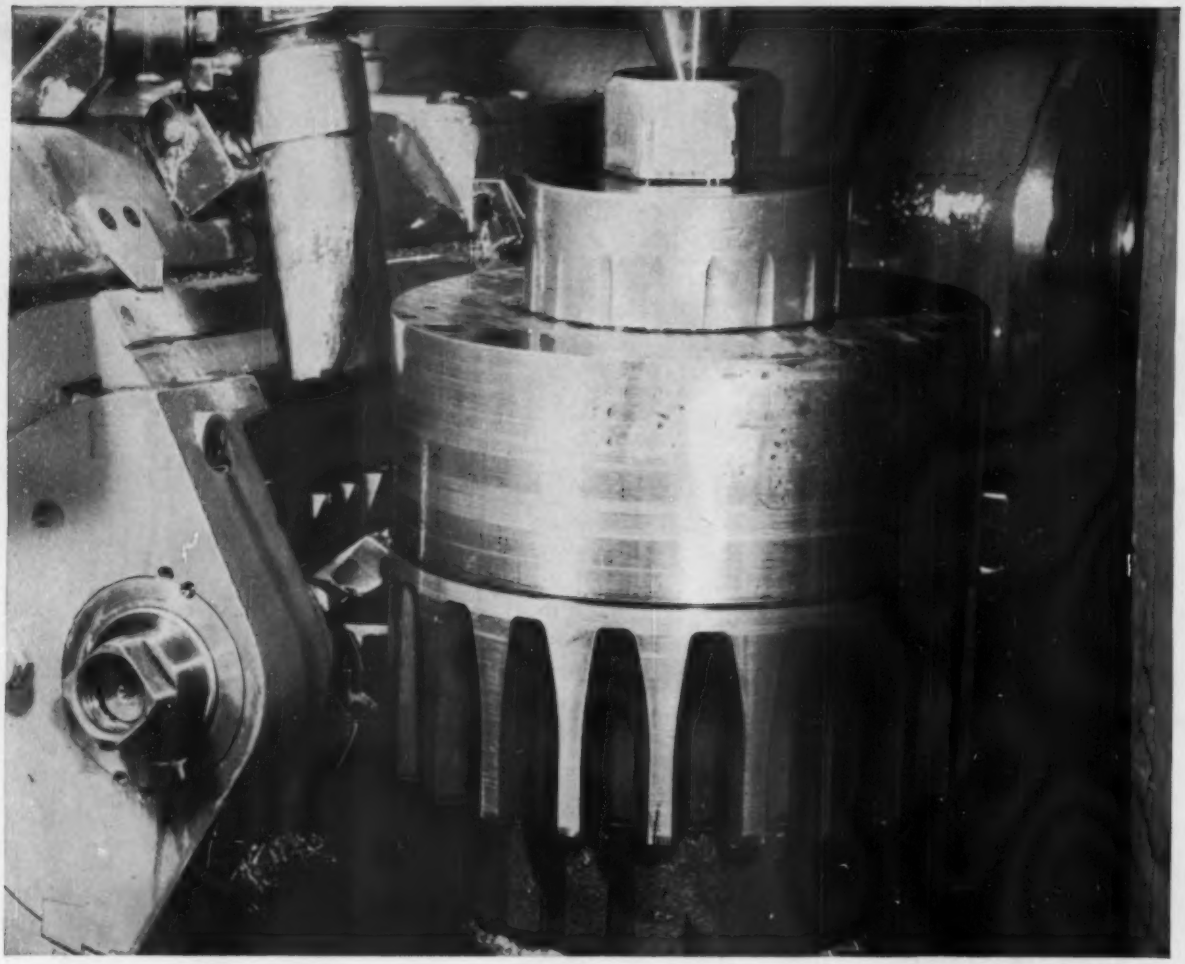

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TABLE 6—TURNING COBALT-CONTAINING ALLOYS[a] —*Continued from page 151*

ALLOY DESIGNATION	CONDITION[b]	TOOL MATERIAL[c]	DESIGN[d]	MACHINING OPERATION						CUTTING FLUID
				ROUGH			FINISH			
				Speed, fpm	Feed, ipr	Depth of Cut, inch	Speed, fpm	Feed, ipr	Depth of Cut, inch	
S-816[e] G. 34 Cobenium; Elgiloy HS-31 X-40 HS-6	Aged	HSS Carbide Carbide Carbide	C M; N; O L L	10-15 25-35	0.008-0.009 0.009-0.012	To insure a bite	30-60 30-40	0.011-0.015 0.005-0.008	0.015-0.047	Sulfur or sulfo-chlorinated oil
HS-21		Carbide Carbide	M; N; O	25-35 10-40	0.009-0.012 0.015 min	0.25 0.25	30-40 65	0.005-0.008 0.008	0.005	General-purpose cutting oil and kerosene
Rexalloy 33 (55 R_C max.)		Carbide	M; N; O	25-40	0.003	0.010-0.02	Generally finished by grinding, using light feeds, with 40 to 60-wheels having hardnesses of X or J			None
AISI T8 Tool Steel	Annealed	HSS	J	18-21 58-62	0.09 0.015	0.25 0.031				Sulfurized mineral oil
		Carbide	R	145-167 238-270	0.031 0.015	0.25 0.031				
M15 Tool Steel	Annealed	HSS	J	37-43 52-60	0.031 0.015	0.125 0.062	Generally finished by grinding			Sulfurized or chlorinated oils with sulfur
		Carbide	R	170-196 223-254	0.031 0.015	0.125 0.062				
M30 Tool Steel	Annealed	HSS Carbide	J S	50-60 185-215	0.015 0.031	0.062 0.062				

[a] Arranged approximately in order of decreased machinability.
[b] Condition for the speeds and feeds indicated.
[c] HSS = high-speed steel; CA = cast alloy
[d] See Table 4 for design data appropriate to the code shown.
[e] Machines best in the aged condition.
[f] Machinable in all conditions.
[g] Rough machine in solution-treated condition. Finish machine in aged condition.
[h] Machines best in solution-treated condition.

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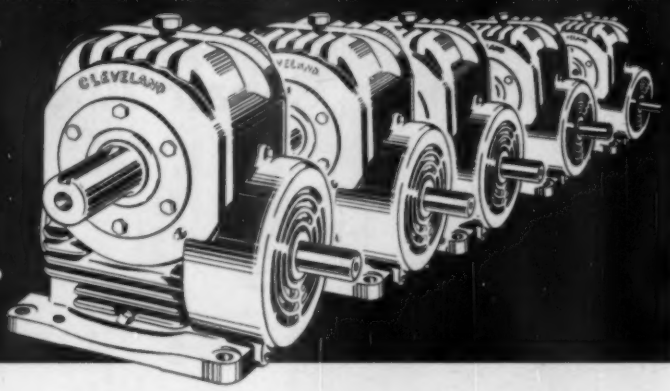

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This permits substantially higher horsepower ratings with smaller worm and gear units — units that more than meet AGMA's new Standard 440.03. Cleveland now offers speed reducers — from one to forty horsepower — at savings of 50% or more on cost per horsepower.

HOUSING is a rugged one-piece design of highest quality cast iron, ribbed for maximum strength and heat dissipation. Cooling fan of unique design is mounted on *input* end of worm shaft and is equally efficient in either direction of rotation. Only one gear shaft bearing plate is large enough to permit assembly of the gear. On gear shaft extension side, gear shaft bearing is mounted in the housing bore and backed up by a clamping plate. This gives a stronger housing and provides maximum strength for overhung loads. Housings are designed for mounting in one position only, thus avoiding design compromises necessary with *universal mount* types.

BEARINGS on both worm and gear shafts are Timken taper roller-type, providing adequate thrust and radial capacity. Worm bearings are mounted directly in housing bore for greater rigidity.

WORMS are cut integral with shaft and accurately ground to a high surface finish on both thread flanks. Shaft extension diameter is especially large to permit increased overhung load capacity. An exclusive heat-treating technique provides a high degree of hardness throughout the entire thread thickness and well below the worm's root diameter. It gives maximum thread strength and resistance to wear without losing the advantage of a tough core of medium hardness.

GEARS have centrifugally cast bronze rims with a high tin-nickel content. They provide greater density and a higher hardness, giving increased resistance to wear and fatigue pitting. Bronze rims are centrifugally cast integral with cast iron centers, in smaller sizes up to 6 inches, which permits strong mechanical keying of the two parts — without dependence on actual surface bond. Gear shaft extension diameters are especially large to permit greatly increased overhung load capacity.

ORIGINAL MASTER WORMS for each size and ratio of worm gearing, are made individually in Cleveland's tool room to extremely close tolerances and kept in perpetual stock. Cleveland makes all their hobs. No outside source has been found that can produce worm gear hobs to their exacting tolerances and standards. Each hob is checked against this master worm — as are production worms and gears. Thus, it's not necessary to ever replace Cleveland worms and gears in sets. A new gear will operate perfectly with an old worm and vice versa.

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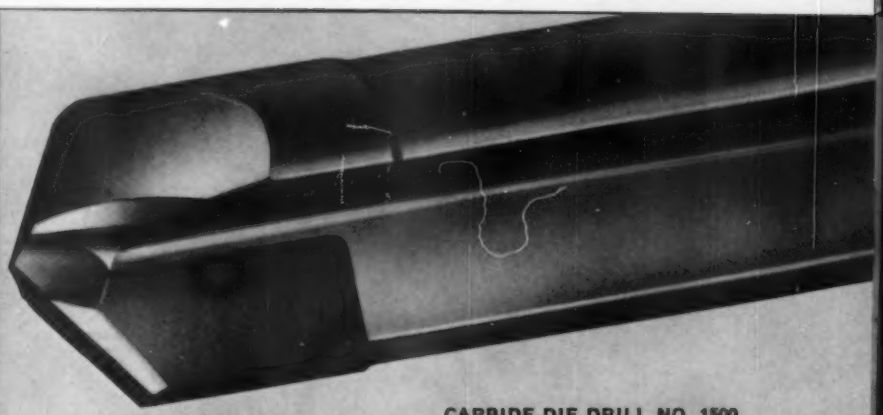

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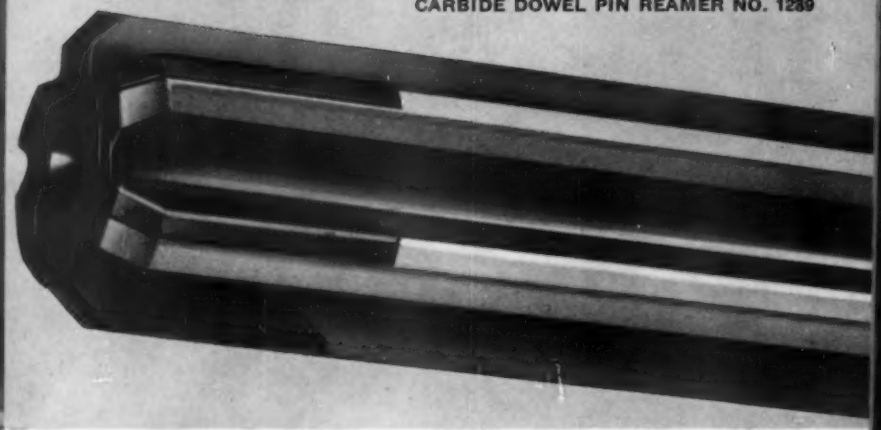

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Talking Shop...

True Tragedy

A PLANT MANAGER, caught in one of those cost reduction programs, had the bright idea that by slowing down the machines he could make the tools last longer and thus make substantial cuts in the cost of tools. He tried it, and it worked just as he thought it would. It wasn't until an emergency trouble shooter arrived from the home office that he began to realize he was wrecking the total cost and the profit of this particular plant.

And Nearly So

ANOTHER PLANT we know is in one of those job shop, special order businesses where making quotations is a big operation. Evidence has accumulated that there is an almost fixed ratio between quotes and orders (this plant is obviously luckier than most) and it was only this evidence that prevented a concerned management from cutting the personnel devoted to writing quotations.

These two tales point a moral so obvious it should need no direction signs. But the fact that we heard them on two successive days recently makes it obvious that it must be repeated over and over: Cost cutting must always be done with a scalpel instead of an axe and the scalpel must be in the hands of a man who understands the structure of the shop and who can tell a tendon from a tonsil.

But You Must Look

THE OTHER SIDE of the coin of cost cutting is that you must look. When competition from abroad forced one company to look seriously at the cost of its product recently a goal on one component was set at a third of the present cost. At first there were screams of "Impossible!" from both design and manufacturing engineers. Then they got really interested in the problem. When last heard from the cost of the component was down to a tenth and they were still working.

Gun Press

A 50-TON, 16-in. gun from the battleship Colorado has been installed at the Dover, Ohio, plant of General Electric. The gun will be used as a hydrostatic pressure chamber in which to make powdered metal compacts from refractory metals such as molybdenum and tungsten. The output will be for both missile and light bulb parts.

Two Blades For One

A SIMPLE ECONOMY was achieved at GE's Aircraft Accessory Turbine Dept when 45 castings make 90 blades in an aircraft turbosupercharger unit. A Haynes investment casting process is used to cast two blades with a common base and shroud to required tolerance and smoothness. Not only is there only half as much casting, there are only half as many pieces to assemble when blades are dovetailed into the hub.

Burred In A Press

PILOT HOLES in pierced parts were burred individually at Ryan Aircraft. Even with portable power tools this was a slow operation and blemishes were caused on the surface around the holes. Two foremen, Louis Paradise and Walt Stringer, came up with a solution: hit the parts between flattening dies in a punch press, pushing the burrs back into the holes. Because these are pilot holes, drilled to larger size on assembly, this method is acceptable and unmarred parts are obtained in less time.

Vanishing Engineers

THIS PAST YEAR the freshman class in U S engineering colleges was 3.4% smaller than the year before. And that class was 11.1% smaller than the year before that. These two decreases are the first since 1950. But why?

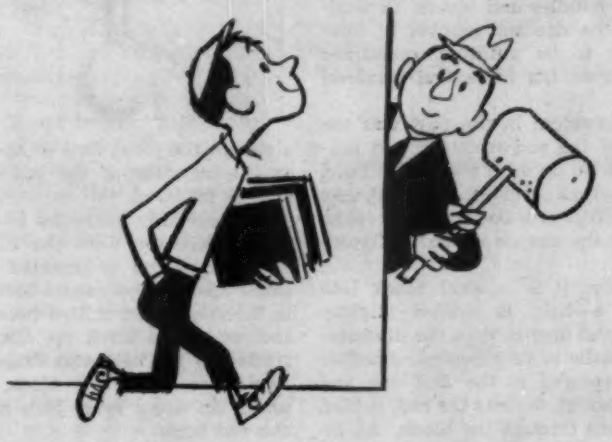
A study by Engineers Joint Council of 151 of the 231 deans of engineering colleges turned up three reasons:

1. Increased interest by qualified students in other fields of science, especially since "science and the space age" has been glamorized in public opinion.

2. Concern over the rigors and demands of engineering education.

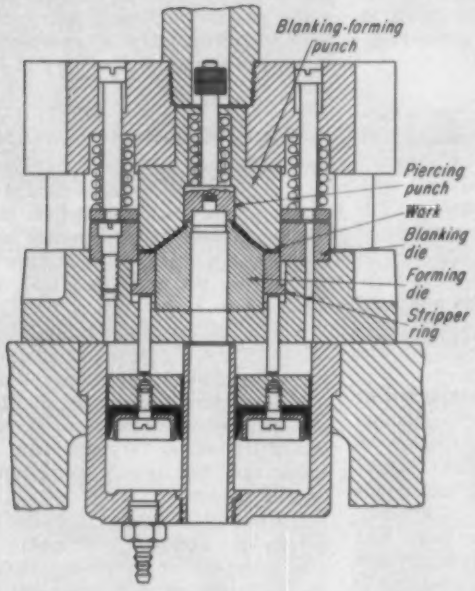
3. Decrease in application from students lacking in genuine interest and motivation for engineering.

Fads we will always have and we can't feel badly about boys who don't belong in engineering going somewhere else. But we can worry about boys who would make good engineers and who never learn what the positive side of engineering is. The place to start that education is in your town and in your neighborhood. Let's hope next year's engineering class is larger and let's do our part to see that young men learn about the very real rewards available to engineers.



Practical Ideas...

Combination Die Blanks and Draws Cup Without Distortion



This die actually performs three operations at once. First, from the strip stock being fed into the die it produces a blank. This begins to take the shape of a funnel as the die closes further to start the second operation. And finally, with the die almost closed, a hole is blanked in the center after which the stroke is completed to finish the part.

As the parts are made from 0.020-in. tinplate, the tendency of distortion by crimping is ever present. My process prevents this in two ways. One, the blank is held by the outer edge during the entire drawing cycle, and two, the central hole is blanked only just before the end of the press stroke.

A complete press stroke goes as follows: A circular disk is blanked from strip stock fed into the die by a combination blanking-forming punch. The blank is immediately gripped between the punch and a pneumatically-operated stripper ring. It is then drawn over a forming die and, contacted by a spring-loaded piercing punch, is pierced approximately 5/64 in. before the press stroke hits dead bottom center. At the bottom the blanking-forming punch spanks the part home to finished size and shape, the central hole being drawn to a cylindrical rim.

On the return stroke, the scrap stock is stripped off the blanking-forming punch by a spring-loaded ring. The part is raised simultaneously to die level by the bottom stripper, but as the diameter of the cup is now smaller there is no problem with it binding in the scrap. An automatically-triggered blow off removes the part as the stock is advanced. No stops are shown for reasons of clarity.

By applying the Guldinus Rules, the disk diameter was easily calculated, but when it came to determining the diameter of the piercing punch, it was a different story. This had to be done by trial and error. Before the right size was found we had made three punches, each a little larger than the next and each time enlarging the hole in the die by grinding. After the third try, the metal flowed evenly around the die to form the rim.

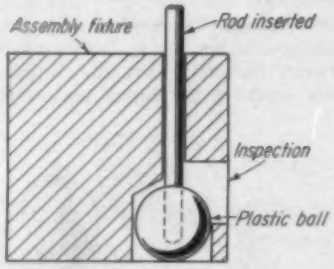
Hjalmar Dahl, Upplands Vasby, Sweden

Simple Assembly Fixture Improves Work Quality

A standard job with us that comes up from time to time is assembling rods into plastic balls to serve as control handles and levers. Depending on the size and number of components to be outfitted, quantities range from ten to several hundred units.

Our problem in the past was the entry of the rod which, if not perfectly lined up with the drilled hole, would crack or split the ball. As the spoilage rate became intolerable, I made the simple assembly fixture shown.

Plainly, it is a steel block into which a hole is drilled slightly larger and deeper than the diameter of the balls to be accepted. Another hole, centered in the first one and large enough to clear the rod, is then continued through the block. An inspection port is provided by milling



a slot in the front face of the block so the insertion of the rod can be closely followed.

The assembly operation is carried out as follows: With the block on its back, a rod is inserted in the small-diameter hole and a ball placed in the large hole, drilled hole facing the rod. Thus lined up, the rod is started in the ball with finger pressure after which the block is slid under an arbor-press ram to drive the rod home.

The spoilage rate has now dropped to zero and production has increased 100%.

J H Sperman, Brooklyn, NY

Punches Resharpened

Hand punches, similar to those used by electricians and sheet-metal workers, are easy to resharpen after they have lost their cutting edge; and without a grinding machine.

Simply remove the punch and die button from the jaws of the hand punch and place the die face down on an oil stone with the punch inside the die. Now, with a circular motion and moderate pressure, rub the two as a unit on the stone. To assure an even cutting edge on the punch, it must not be allowed to rock in the die.

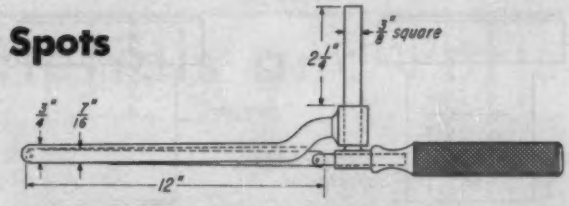
This method applies, of course, only to flat-end punches; not to punches with center points.

S Clark, East Bradenton, Fla

Novel Hacksaw Works in Tight Spots

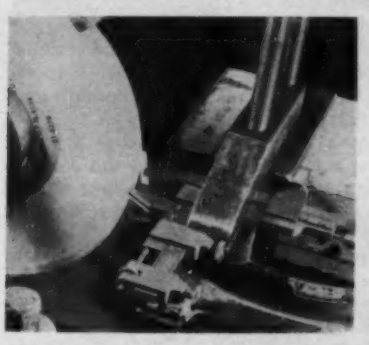
Some hacksawing problems can be solved by rotating the blade 90°, and at other times by using a large-throat frame, but on occasions, neither of these methods will be enough to overcome a particular obstacle.

When I designed and made the illustrated frame some years ago, I had one of these tough ones to tackle. A slot had to be sawed from a hole only slightly larger than ¾ in. and its location was too far from any edge to apply the tricks mentioned. This tool, however, successfully filled the need. With the blade in the position shown, the cut was started and as the cut progressed, the frame was opened to increase capacity. This is done by loosening the handle, then moving the frame up the frame post, and again tightening the handle.



The frame and the frame post are made of a good grade of tool steel as is the tension screw. After the frame has been bent as shown and provided with a ⅜-in. square hole for the post, a slot 1/16 in. wide by 7/16 in. deep is cut lengthwise into the underside of it. This permits the blade to enter the frame, exposing only the teeth when in closed position; a practical feature when storing the saw with other tools. Fully open, the frame is capable of handling a 2¼-in. deep cut. The knurled handle is made of aluminum.

Alden C Sorenson, Ogden, Utah



Accuracy of Tooth Vernier Caliper Restored

Tooth vernier calipers are widely used and often indispensable in jobbing shops, but are vulnerable in one respect. Wear is concentrated on the inside edges of the two jaws which enclose the flanks of the gear teeth. When these edges are blunted in the least, the instrument has lost its accuracy. This is, however, easily restored by the method shown in the photo.

The caliper is held in a toolmaker's clamp which is in turn gripped in a machine vise or a grinding vise so the jaws extend into the clear. Their position is then checked with an indicator to make sure of their parallelism with the grinder-table feed.

A thin, fine grit wheel (100 grit or finer of medium hardness) is used to clean up the two inside jaw faces; and only enough to bring out the sharp corners on the extreme ends. This is best done with a narrow working flange on each side of the wheel at its periphery which is produced by recessing slightly behind the edge during dressing.

To restore the instrument to its original accuracy, it is usually necessary to remove only a few thousandths of an inch. The loss is compensated for by loosening the vernier plate and moving it to, and again securing it at, the new location.

It may be desirable to lap the jaw faces for a final finish, but we have not found this necessary when proper care is taken in grinding. However, if lapping is done, a rotary lap similar in shape to the grinding wheel should be used to prevent distorting the geometry of the jaw faces.

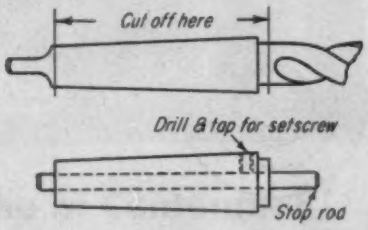
H J Gerber, Stillwater, Okla

Drill Shank Is Adjustable Stop

Why do so many shops keep a scrap bin for old files and broken drills? The reason is probably, to a large extent, for convenience rather than economy. Because there is no way of telling when a good piece of steel or a stub drill will be needed.

An example of this is the subject in question. I recently had to have a stop which had to be adjustable, give me a positive stop, and be seated in the headstock just inside the chuck jaws. The body of the tool I finally came up with was the tapered shank of an old drill dug out of the scrap bin.

First, both ends of the taper were squared off and, as drill shanks are generally left soft, I had no trouble



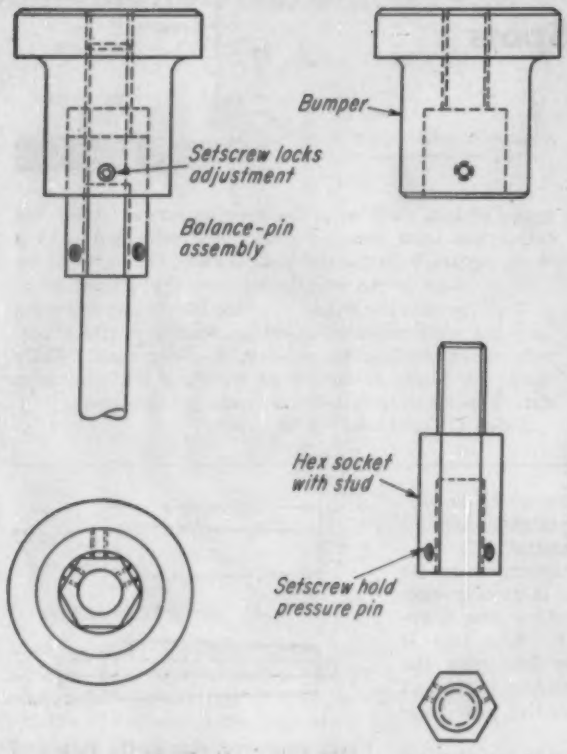
here. However, should the flute end be too hard to machine, it can easily be annealed by heating to a bright red and allowing to cool slowly.

Next, the shank was placed in the lathe spindle and a hole was drilled and reamed through its axis. This hole later received a rod to make the stop adjustable. Rod diameter is, of course, optional, but should be as heavy as the shank or the work diameter will permit, and its length is determined by requirements. A headless setscrew locks the rod in the shank.

Hugh A Wells, Winston Salem, NC

Practical Ideas...

Adjustable Balance Pins Save Press and Equipment



What takes place when an off-center die is used in a press where no or inefficient balance pins are employed with a cushion? The answer to that one is simple. The cushion is likely to be damaged because of the off-balance load, but what may be even more serious is the fact that undue strain is put on the press ram and bearings.

Good balance pins, preferably those that are adjustable and properly applied, are the best solution. These pins should be placed where little or no pressure is exerted by the die functions. They are used in multiple-die sets where a drawing operation is being done at one end and light trimming or forming at the other. And they reduce the shock of breakthrough in an off-balance blanking die.

As a rule, balance pins are used only when a cushion is required. In other words, when a die is designed to operate with a cushion and pressure pins, balance pins may also be necessary. Their function is to equalize pressure on the cushion and the die in general when it is of necessity off center. They are generally located near the corners of the cushion and through the pressure-pin holes; in fact, they should be of the same diameter as the pressure pins.

The major advantage of this unit is that its pressure pins may be removed and replaced with either longer or shorter ones without further machining. This allows their use in presses of various shot heights and in many different dies.

The assembly shown is designed for 1-in.-dia pressure pins. The pins are made as near to the correct length as possible and placed in the hex sockets where they are secured with two headless setscrews. Adjustments are made by screwing the hex socket in or out of the bumper portion, which is threaded to accept the stud in the hex. After the correct height has been attained, the setscrew in the bumper is tightened to bear on one of the flats of the hex.

Edwin H Stock, Affton, Missouri

Watch Crystal Makes All-Directional Level

An instrumentation setup we were recently working on required accurate leveling at several points simultaneously. Small all-directional levels, or button levels as they are sometimes called, would have been the logical answer, but none was readily available. To replace them we devised a subterfuge, using the same principle, of material we could get and came up with an equally effective instrument.

It consists of a small watch crystal and a slightly larger plain glass plate cemented together after filling the cavity with water. If carefully done, this should leave a small air bubble under the crystal which is encircled while the level rests on a surface of known level accuracy. Careful handling is imperative.

Yosiro Honda, Hirazuka, Japan

E M Bladholm Huntington Park, Calif Won $25 for his idea:

CENTERING GAGE SPEEDS MILLING-MACHINE SETUP in the April 14, 1960 issue

AN EXTRA $25 will be paid for the best Practical Idea in each issue of *American Machinist/Metalworking Manufacturing*. Selection of the winning idea is made by a group of our readers.

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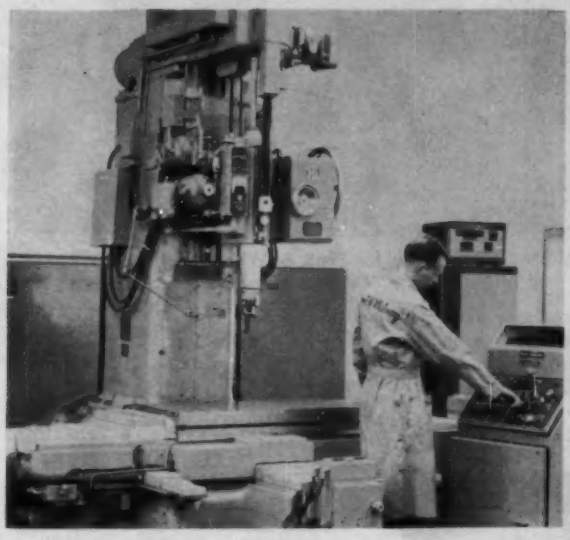
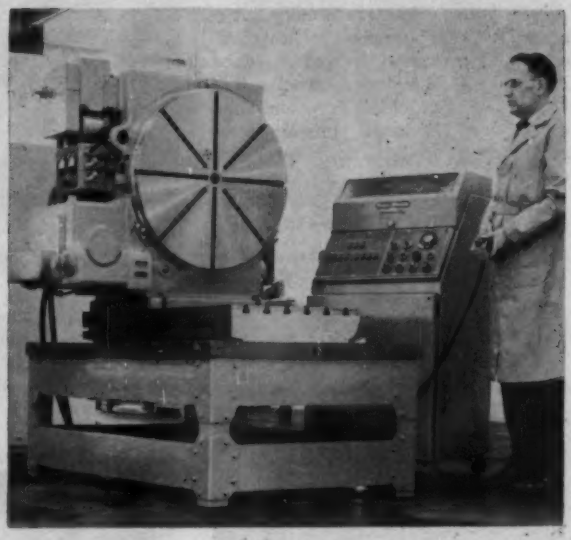
New Shop Equipment

Materials and Parts





P&W Introduces Borer, Rotary Table, Lathe at Centennial

As a part of its 100th anniversary celebration, Pratt & Whitney Co introduced three new machines. On display at the West Hartford (Conn) Centennial Hall, a numerical-head jig borer, a 30 in. vertical tape controlled rotary table, and a lathe made for the company in France form a part of the exhibition of P&W machine tools.

Jig borer

In addition to automatic positioning of the table under the control of a tape-reading numerical system, the jig borer also provides fully automatic selection of spindle speeds and feeds, automatic rapid-traverse positioning of the spindle and quill above the work, and automatic control of the boring depth and cycle.

By extending numerical control to the operation of the spindle, this new borer provides industry with a super-accurate machine capable of performing an entire series of precision machining operations automatically. The operator has only to clamp the work on the table, start the automatic cycle, and change tools.

Tapes are often prepared even for single-piece jobs. However, for the occasional jobs where use of a tape is not desired, positioning data for both table and spindle can be fed into the system manually, using a telephone-type dial control. The machine is equipped with the Electrolimit measuring system, and a floating zero, a feature that makes it possible for operator to establish or reestablish the zero point for a machining job at any convenient location or reference point.

Rotary table

Suited for either inspection or machining operations, the 30 in. vertical rotary table may be mounted on a surface plate, or the table of a milling, drilling, or boring machine.

Table working surface will automatically position to any desired point in 360°, accurate to 5 sec of arc, with repeatability to 2 sec of arc. Digital positioning information may be introduced either by telephone dial or by punched coded tape. For setup purposes, rapid rotation in either direction can be accomplished through push button controls. Positions of the table are expressed in degrees and decimals of a degree, and a digital display panel gives visual represenation of the table position.

All positioning of the vertical rotary table is accomplished in relation to a pre-set zero, which can be set anywhere on the periphery of the table. Final settings are always made in the same direction and in the same manner eliminating all tension and feed screw strain. The table incorporates the Electrolimit measuring system.

SIM lathe

The ten-inch production lathe announced by P&W is manufactured by French firm Les Innovation Mechaniques. It is said to offer exceptional quality and precision at an unusually low price. Carrying the same guarantee of materials and workmanship as all P&W machine tools, the SIM lathe is reported to deliver toolroom accuracy and extremely fine finishes. Lathe is equipped with a 7½ hp motor.

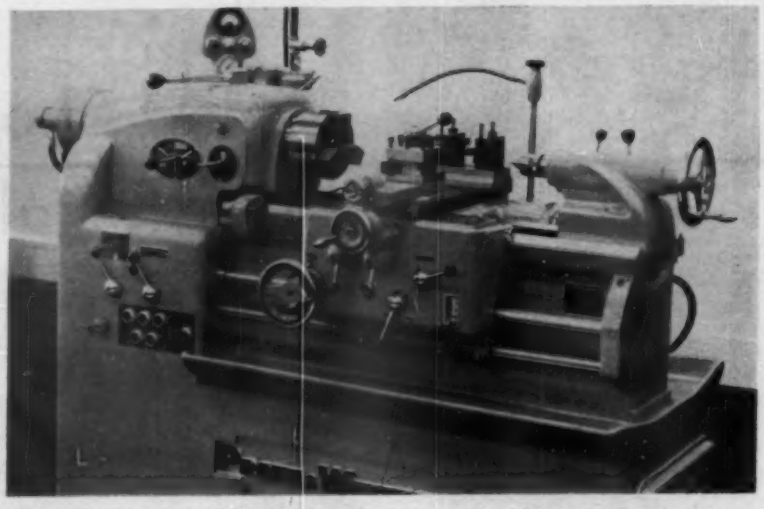
Several features are said to make this machine ideal for efficient, eco-

nomical small or medium lot production. A single-lever control starts and brakes the spindle, and opens or closes the air-operated chuck. Operating pressures for the chuck itself are infinitely adjustable from 0-22.5 psi. There are 9 forward and reverse speeds and 9 longitudinal and transverse feeds. Speed and feed controls are color coded for easy selection of combinations.

Bed and frame are heavy, integrated units. V-type ways are hardened and precision ground in place. All gears are hardened, ground, and individually matched. Precision spindle of case hardened chrome nickel steel is mounted in three precision roller bearings.

Pratt & Whitney Co, Inc, Charter Oak Blvd, West Hartford, Conn

MORE DATA? Circle 51, inside back cover



TEN-INCH PRODUCTION LATHE made for Pratt & Whitney in France

Rotary Tables Combine Extreme Accuracy with Digital Readout

Precision rotary tables are reported to be capable of indexing from any point in 360° to any other point with an accuracy of ± 1.5 sec of arc. Believed to be the most accurate non-optical rotary tables ever manufactured, these devices were specifically designed and developed by Pratt & Whitney for use as azimuth indicators in missile aiming systems.

In addition to their extreme accuracy, these tables also feature digital readout, which is said to insure unusual speed, ease, and dependability of operation. Degrees, minutes, and seconds are read directly on counter-type indicators. There are no optical scales or verniers.

While it is believed that the principal applications for these tables will be in similar missile aiming systems, the manufacturer points out that these tables are exceptionally rugged and are suitable for any industrial applications where extremely accurate circular spacing or angular positioning is required.

Pratt & Whitney Co Inc, West Hartford 1, Conn

MORE DATA? Circle 52, inside back cover

Portable Radiant Unit Heats Exotic Metals to Forming Temp

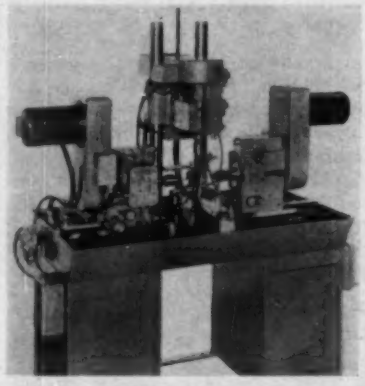
Portable radiant heater heats metals such as titanium, magnesium, Inconel, molybdenum and their alloys to forming temperatures. Stationed right at the drop hammer or press, the heating unit eliminates rejects that result when metal ductility is weakened through heat loss during transfer of blanks from remote oven to forming facility.

A gold-plated retractable lamp head holding up to 99 infra-red quartz bulbs delivers temperatures up to 1500 F at the forming block. It does away with the need to heat soak blanks to compensate for oven transfer loss in temperature.

The lamp head, operated by remote cable controls, can be raised or lowered, extended and retracted over the workpiece. Lamps cut off the instant the head retracts. Heads are adjusted pneumatically and fan cooling protects against overheating. Blanks can be heated and formed in seconds with elongation increased as much as 11%.

Electric Hotpack Co, Inc, 5035 Cottman St, Philadelphia 35, Pa

MORE DATA? Circle 53, inside back cover



Triple-Spindle Drilling Unit Speeds Secondary Operations

Automatic triple-spindle machine for drilling, tapping and threading performs secondary operations on screw machine and headed parts, die castings, stampings and molded plastic parts. The machine has two horizontally opposed spindles and one vertical spindle. Each can be cycled individually or in any combination with the other two.

Each drive motor provides spindle speeds of 500 to 10,000 rpm. Dovetail mounting permits 11-in. major

adjustment plus 2½ in. of spindle stroke control. Twin double-acting air cylinders advance and retract each spindle. Capacity is 0.020 to ⅜ in. drilling and ⅜ in. tapping in mild steel.

Universal-Automatic Corp, 9545 Ainslie St, Schiller Park, Ill

MORE DATA? Circle 54, inside back cover

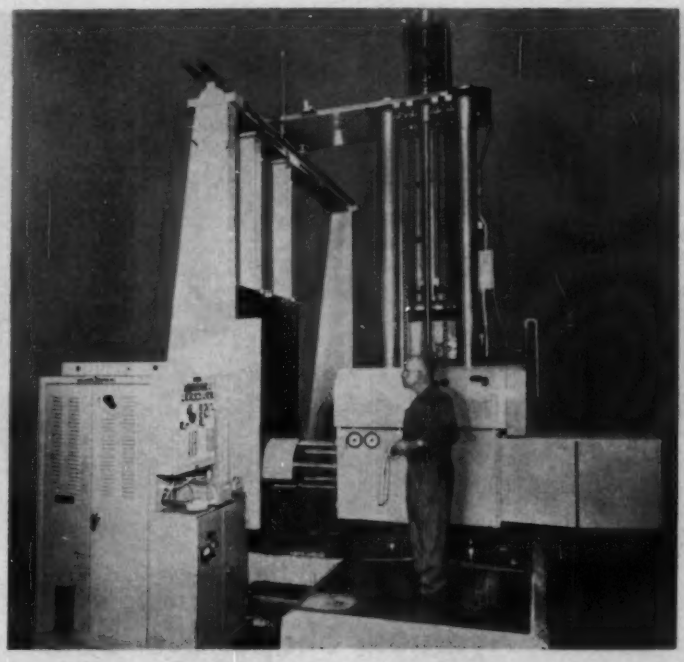
36-in.-Wide Tantalum Sheet Now in Commercial Production

New size sheet, 36 in. wide by 72 in. long, produced by a newly perfected process, is priced at $59.16 per pound —same price as for smaller size sheets. Widest previously available measured 24 in. The new sheet is 0.020 in. thick and weighs 32 lb, but longer and thicker sheets are also available.

The sheet is for use primarily in the construction of chemical reaction tanks. Currently two or more conventional size tantalum sheets requiring two or more welds are used in such vessels. The new large sheet will eliminate as much as 50% of the complex welding process.

Kawecki Chemical Co, Boyertown, Pa.

MORE DATA? Circle 55, inside back cover



Hill Numerically Controlled Jig Driller Makes Holes in Parts up to 10 ft Square

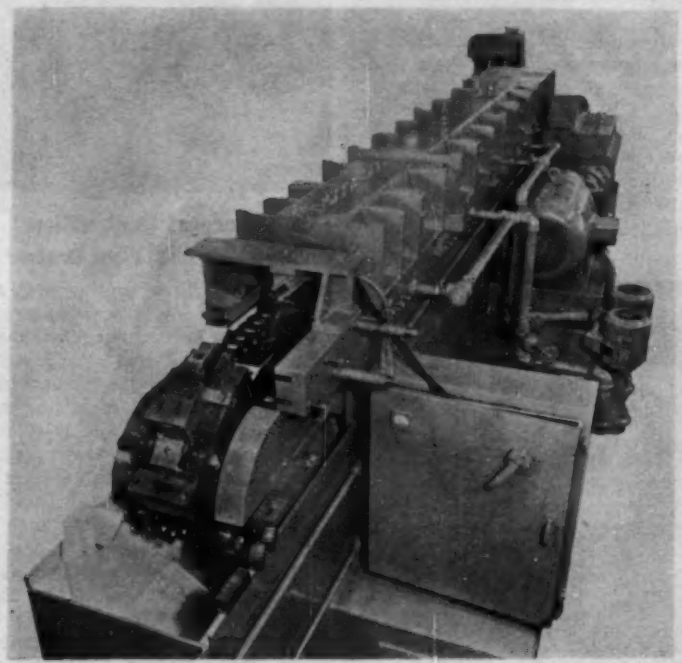
Numerically controlled machine designed for programmed drilling of holes in parts or groups of parts measuring up to 10 ft square is ideally adapted to the drilling of hole patterns and bolt circles in condenser tube sheets. Sheets or vessels longer than 10 ft but within the 10 ft height dimension can be handled on the machine by proper setup. A part 33 ft long can be run on one tape.

A floating zero arrangement enables a number of smaller parts to be clamped simultaneously in work fixture and accurately drilled under tape control. Positioning of the single-spindle drill head can be accomplished manually, manually by decade button, or by punched tape control. Tachometers on the head indicate feed and speed at all times. Machine can produce holes by either gun drilling, pressure-coolant reaming, grooving, or drilling with oil-flute twist drills.

The quill is advanced by a pair of hydraulic cylinders. The drill spindle is powered by a 15 hp motor. Sixteen speeds are available in a range from 50-5000 rpm. Feed rates for drill spindle are up to 120 ipm. Maximum quill travel is 26 in.

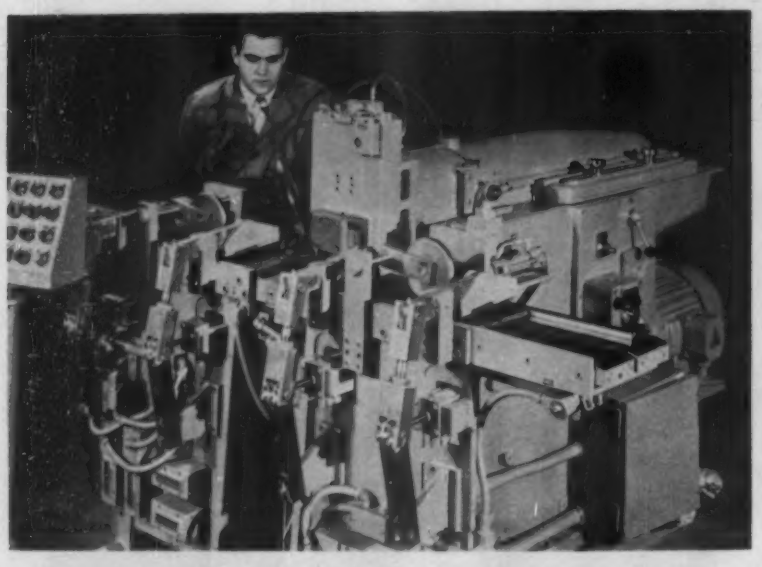
Walter P Hill, Inc, 22183 Telegraph Rd, Detroit 19, Mich

MORE DATA? Circle 57, inside back cover



CONTINUOUS HORIZONTAL BROACHING MACHINE is said to be largest of its type ever built. Machine, which has 144-in. stroke, produces 182 pieces per hour from nine fixtures running at 13.6 fpm. Broach, which uses 40 hp, 750 rpm 50-c motor, gives surface finish tolerances from 18-25 microfinish on all broach surfaces of automobile parts—*Detroit Broach & Machine Co, Rochester, Mich*

MORE DATA? Circle 56, inside back cover



Rockford Machine Said To Be First Automated Hydraulic Shaper Ever Built

Hydraulic shaper with full automation, believed to be the first of its kind, fits into conveyor line production of sleeve bearings and runs continuously without attention from operator.

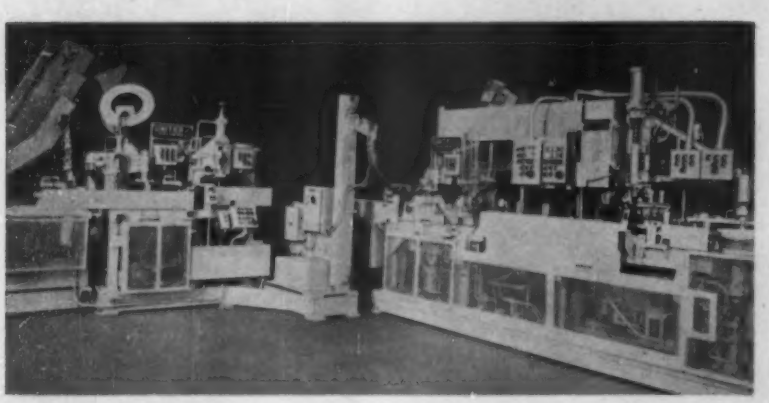
With full automatic cycle, including loading and unloading, this shaper finish-machines one vertical and one angular surface on edge of each of two steel plates simultaneously. Machining is completed in 9 cutting strokes, utilizing a cutting speed of 40 fpm, with 100 fpm return.

Machine is a standard 24 in. shaper, with a special crossrail and toolhead, and equipped for complete automatic cycling. Transfer and index are pneumatic against gauge stops; clamping, tool relief, and tool positioning are hydraulic controlled. Toolheads have positive mechanical feed.

With built-in safety devices to protect operators and prevent machine damage, the shaper is powered by a 10 hp, 1220 rpm, 220-440 v motor. Hydraulic pump is located inside machine column.

Rockford Machine Tool Co, 2500 Kishwaukee St, Rockford, Ill

MORE DATA? Circle 58, inside back cover



WELDING OPERATIONS are included in special-purpose assembly machines. Two straight-line units combine as one automatic assembly machine for joining eight separate parts into automobile oil filters. One operator assembles the parts with four welding and two mechanical joining operations at rate of 900 filters per hour—*United Welders, Inc, Bay City, Mich*

MORE DATA? Circle 59, inside back cover

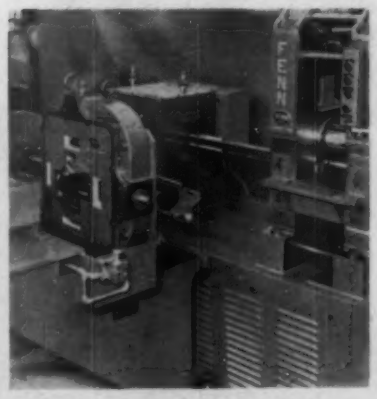
Motor Load Controller Measures Real Load In Kilowatts

Motor load controller measures real load in kilowatts and indicates percentage of rated load. According to the manufacturer, most controllers sense load simply by measuring current which gives only an approximate measure of torque within a limited range.

The unit can be used with any machines that use ac induction motors for driving power and will operate with single or three-phase systems at 110, 220 or 440 v. It senses both voltage and current and measures the phase angle between them. If the amount of overload exceeds a pre-set percentage, the unit actuates an alarm or shuts down the machine. Cost of the complete system is $195.

Seneca Falls Machine Co, 23 Fyfe Bldg, Seneca Falls, NY

MORE DATA? Circle 60, inside back cover



Fenn Introduces Combination Rolling Mill And Wire Drawer

Combination 2-in-1 rolling mill and wire drawing machine was designed to meet the special requirements of many metallurgical laboratories where versatility and compactness are essential. Unit includes, on a common base, Model 4-053C two-high/four-high, three-way precision rolling mill, and a wire drawing attachment for producing various shapes from round wire, such as squares, rectangles, and trapezoids.

The latter includes a draw die box, a Model 4U turks head, and a shedding type drum. Both elements derive their power from a common drive. Manufacturer states that the cost is considerably lower than that of separate units because of the common drive and bed features.

Fenn Manufacturing Co, Fenn Rd, Newington, Conn

MORE DATA? Circle 61, inside back cover

Gear Deburring Machine Handles 3 to 36-Inch Diameter Gears

Model 36 is designed to deburr and chamfer large spur, helical, worm and bevel gears and splines. A floating wheel spindle automatically follows the contour of the tooth. No wheel dressing, change gears or followers are required.

The machine handles external gears with pitch diameters up to 36 in. and internal gears with pitch diameters up to 32 in. Minimum pitch diameter is 3 in.; minimum diametral pitch is 16; maximum gear face is 12 in. Work speed ranges from 0.5 to 5 rpm. Maximum wheel speed is 11,000 rpm. Work spindle handles loads to over 2000 lbs.

Photo shows a 34½-in. diameter steel gear, weighing 1250 lbs, being loaded on the machine. The gear took two minutes per side to deburr.

Redin Production Machine Co, 2433 20th St, Rockford, Ill

MORE DATA? Circle 62, inside back cover

Two Ceramic Powders for Tools, Jigs, Withstand Heat, Pressure

Two new ceramic powders, Corcast and Cortamp, can be formed into shapes used in hot tooling. First applications will be as tools, jigs, and fixtures in the aircraft and missile industry, where shaping of exotic metals requires great heat and pressure.

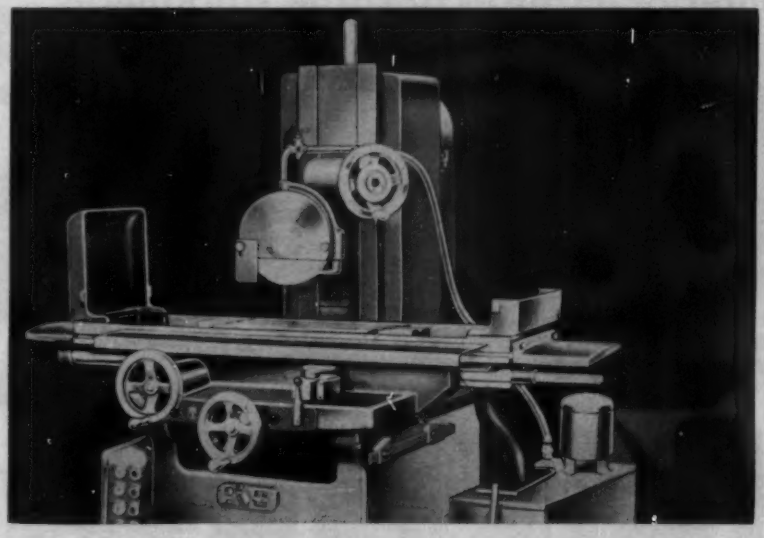
The manufacturer cited these chief features: Users of the powders form the shapes they want. No separate firing is required; bonding occurs in use. Temperature capabilities go up to approximately 2500-4000 F. Compressive strengths are high. Dimensions remain stable in use.

Shapes in Corcast, a hydraulically bonded petalite, are formed by casting. Drying causes negligible shrinkage, and no additional work is needed to put a piece into use unless grinding is desired.

Cortamp, a multi-bonded zircon, is formed by compaction. Shapes are held together initially by an organic bond, which shifts to a chemical bond at 1300 F. and to a ceramic bond at 2700 F. Service temperature of ceramic bonded Cortamp is above 4000 F. Cortamp pieces can be ground and machined.

Corning Glass Works, Corning, NY

MORE DATA? Circle 64, inside back cover



NUMERICALLY CONTROLLED turret drilling machine locates and drills holes to accuracies of 0.001 in. per foot at rates up to 15 holes per minute—*Hillyer Corp, Cranford, NJ*

MORE DATA? Circle 63, inside back cover

Hydraulic Feed Surface Grinder Features Micro Inch Finish at Production Speeds

Built around a solid one-piece column and base, No. 206 assures permanent alignment between vertical head ways and cross travel ways. Amount of cross feed on the fully hydraulic grinder is controlled from a panel on saddle front and cross feed itself is variable up to ¼ in. per table reversal.

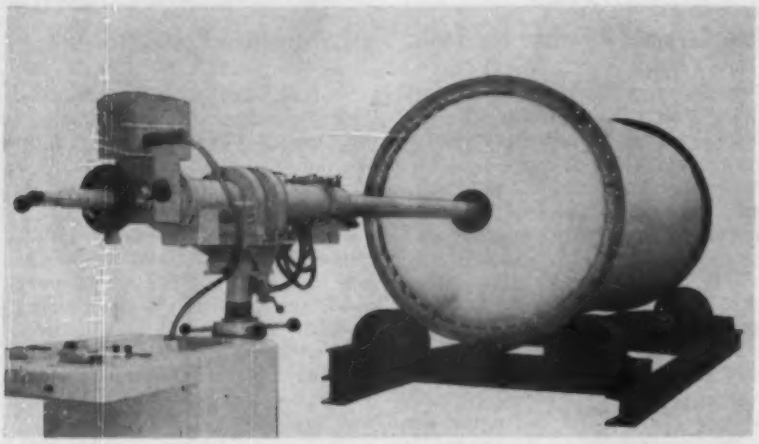
Machine is equipped with a vane type pump and control valve which give an infinite number of longitudinal table speeds up to 110 fpm. Also provided is a variable speed continuous cross feed for dressing or quick positioning. Saddle may be automatically reversed at any predetermined point by adjustable dogs.

Large hand wheel, used for coarse vertical adjustment and graduated in widely spaced thousandths, moves 0.012 in. with each turn. Severe service demanded by use of diamond wheels is no problem since machine has a rubbed, four-bearing grease-sealed spindle. Spindle requires no lubrication for life of bearings.

No. 206 is regularly equipped with an 8-in. grinding wheel, with 13 in. capacity under wheel and 14 in. of vertical movement. Net weight without accessories is 3300 lb.

Gallmeyer & Livingston Co, 430 Straight Ave, SW, Grand Rapids 2, Mich

MORE DATA? Circle 65, inside back cover



Optical Checker Can Inspect Inaccessible Interior Surfaces of Large Workpieces

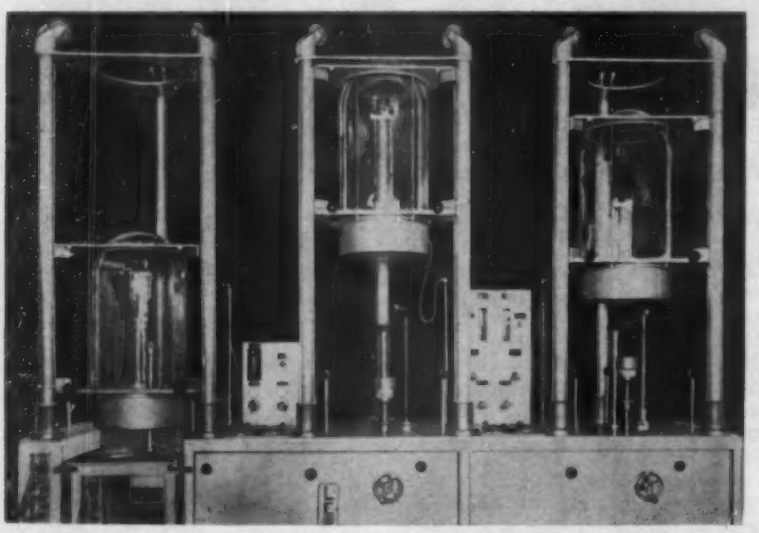
Aerojet Optical Checker is designed to inspect structures whose internal surfaces are irregular in shape and difficult to view because of remote access openings of small diameter. The device was developed to view the interior propellant surfaces of solid-fuel rocket motors but can also be used for tanks, pipes, boilers or airplane wings

Specifications: tube diameters from 1¾ to 5 in. OD, tube lengths to 30 ft, zirconium arc or filtered incandescent lamp at intensities up to 2000 ft-candles, constant magnification up to 2X, minimum 4-in. depth of focus, 1¾ by 2-in. average field of view. It can be supplied as a portable model or mounted on rails or casters. Extras include camera, binocular eyepiece, automatic focus, motor-driven mirror.

Optical checking units can be tailored for special internal inspection requirements.

Power/Equipment Div, Aerojet-General Corp, Box 296 Azusa, Calif

MORE DATA? Circle 66, inside back cover



LINE OF PRODUCTION FIXTURES braze metal assemblies under a controlled atmosphere by induction heating. The reducing atmosphere prevents oxidation during heating, thereby eliminating the need for flux. Joints produced are said to be uniformly sound and free of residual or entrapped flux—*Lepel High Frequency Laboratories, Inc, 55th St and 37th Ave, Woodside, N Y*

MORE DATA? Circle 67, inside back cover

Browning Increases Line of Power Transmission Materials

Variable pitch sheaves, both spring loaded and manually controlled, and adjustable motor bases have been added to line. The sheaves can be adapted to nearly any machine using a single V-belt, and may replace ordinary sheaves. Simply by adjusting center distance, they provide a wide speed range. The motor base provides a means of center distance control.

Both sheaves come in four models, with OD from 3-6 in., pitch range from 1.4-5.7 in., and stock bores of ½-1 in. The list price for spring loaded sheave varies from $8.20-21.40, and for the manually controlled type from $15.40-32.00.

Adjustable motor base lists for $22.20, and is designed to handle motors up to and including frame 204.

Browning Manufacturing Co, Maysville, Ky

MORE DATA? Circle 68, inside back cover

Vernier Simplifies Light Wave Measurement

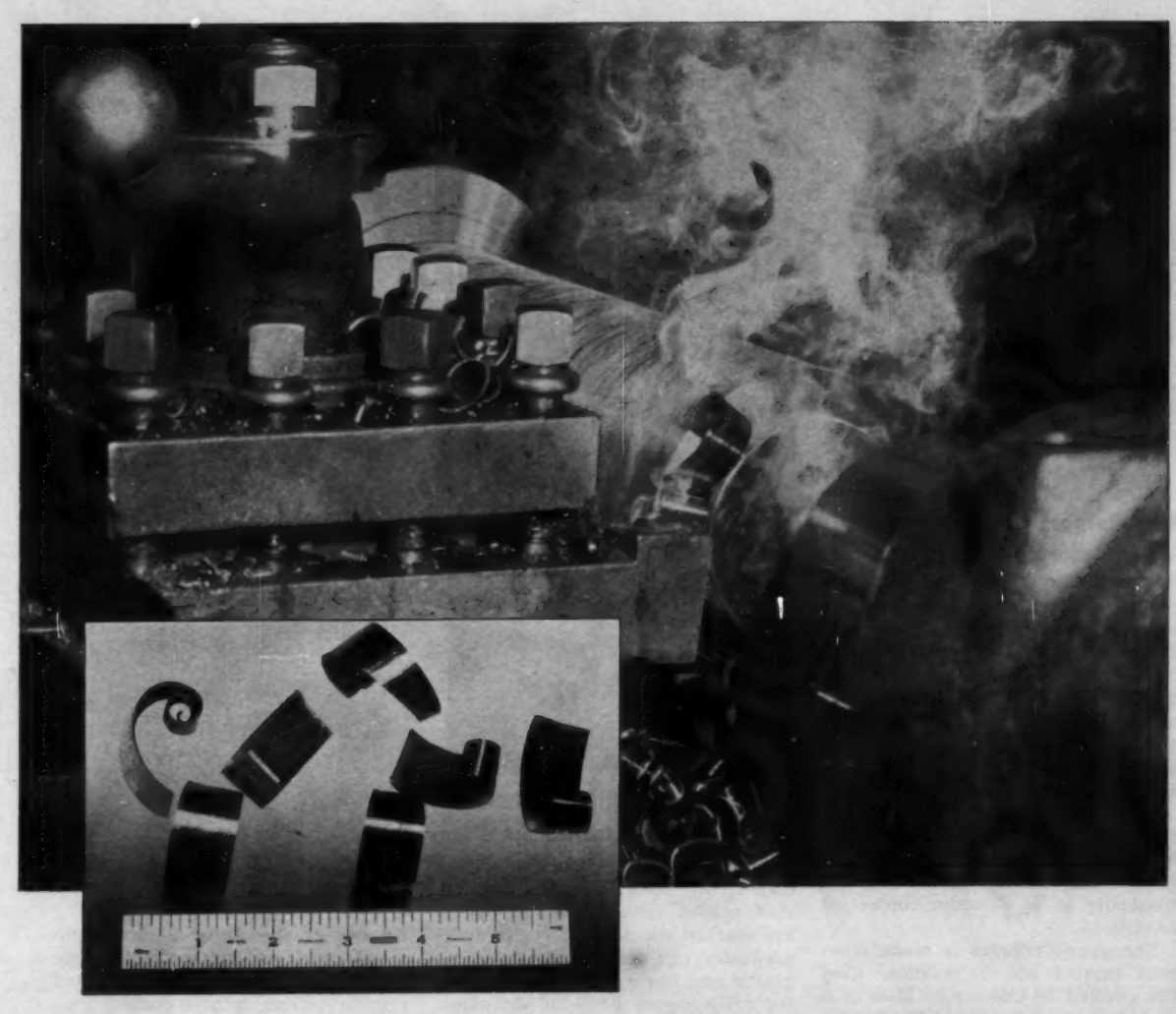
Light band vernier, used with a monochromatic lamp and optical flat, establishes an accurate linear value for light band interpretations. Simple arithmetic can be used to convert this value to a precise equivalent in millionths of an inch.

The cross-hair image is aligned on one band, and the vernier slide is moved until the cross-hair image is aligned on the next band. This is read on the vernier as the band width value. Using the same technique of alignments, the curvature of a single band can be measured. This value divided by the band width value give the flatness of the part in light bands.

Made of aluminum, the device costs $39.75 and can be used with optical flats up to 6 in. in diameter.

Acme Scientific Co, 1450 W Randolph St, Chicago 7, Ill

MORE DATA? Circle 69, inside back cover



Chips like these boost machine output at HEWITT-ROBINS

The ability of VR-77 on heavy interrupted cuts gives Hewitt-Robins maximum machine output per dollar of machine investment. At their Robins Conveyors Division Plant in Passaic, New Jersey, VR-77 is used for maximum metal removal on 1045 cold rolled steel, taking a 0 to ⅛" cut at 300 s.f.p.m. with a .026" feed. Downtime has been cut in half because VR-77 removes twice as much metal per index as the previously used carbide brand.

Regardless of your particular machining problem, there's a V-R carbide specifically engineered to help you boost your machine output.

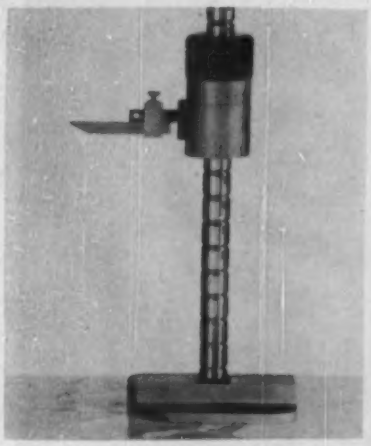
Send for Catalog VR-58 for complete details.

CREATING THE METALS THAT SHAPE THE FUTURE

V-R VASCOLOY-RAMET

832 MARKET STREET • WAUKEGAN, ILLINOIS

C-773



Multi-Purpose Height Gage Faster, Accurate to 0.0001 In.

Height Master is an accurate, quick change, multi-purpose gage designed for use in inspection, precision layout work, and checking jigs and fixtures. Patented gage gives accurate measurements to 0.0001 in. and eliminates need for expensive gage blocks and transfer gages. Speed and ease of operation reportedly reduce inspection costs up to 70%.

Standard and over size gages, from 17-108 in., with a wide variety of accessories are available. Each gage is individually calibrated electronically at 70 F under controlled conditions.

The gage's column is made from heat treated 440 C stainless steel Rockwelled to C60 scale. Base is a non-tipping design of Meehanite, copper, and chrome plated with satin finish.

United States Chemical Milling Corp, 1700 Rosecrans Ave, Manhattan Beach, Calif

MORE DATA? Circle 70, inside back cover

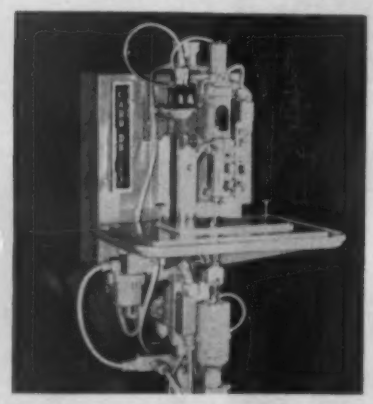
Scherr-Tumico Rids Vernier Caliper of Parallax Problem

Mauser vernier caliper No. 193 eliminates troublesome parallax of the standard vernier by using a flush type vernier. Reading thus becomes practically foolproof. At the same time, eye strain is considerably reduced by the lustro chrome finish on both scale and verniers, the length of which has been doubled for greater accuracy.

Both upper and lower vernier plates are independently adjustable (up to 0.020 in.). A fine cam-lock adjustment is provided for easy setting at close limits. Designed for outside, inside, and depth measuring, it has a maximum capacity of 6¼ in. with 0.001 in. reading on both scales and an overall length of 9⅛ in. Caliper retails at $19.75.

Scherr-Tumico Co, 200 Lafayette St, New York 12, NY

MORE DATA? Circle 71, inside back cover



Circuit Board Drilling Machine Handles Panels Stacked Six Deep

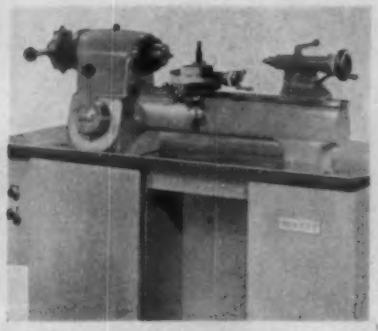
Circuit-board drilling machine, called Carr-Drill, drills holes in copper-clad plastic laminate while panels are stacked six deep. It cycles automatically, can drill metal as well as plastic and has a woodpecker action for drills under 0.030 in. diameter.

The machine also prepares the stylus templet which is used to locate the stack of panels over the drill spindle center. The drill head runs at 2500 to 15,000 rpm and has hydraulically controlled feed.

To prepare a stylus-templet, the operator target-drills and countersinks holes in a copper-clad panel. The stylus is placed on the stack of circuit boards and the stack is maneuvered to bring the stylus over the selected holes. A foot-switch causes the stylus to move down and engage the countersunk hole, pinning the stack together with 30 to 60 lbs of force. The drill-head then moves into position and drills the boards.

Curt Carr Co, Box 1205, Pomona, Calif

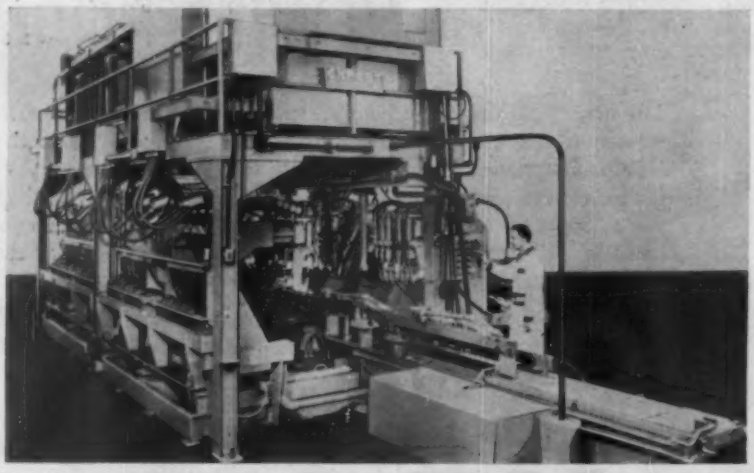
MORE DATA? Circle 72, inside back cover



Precision Lathe Claims One Motion Control, Other Firsts

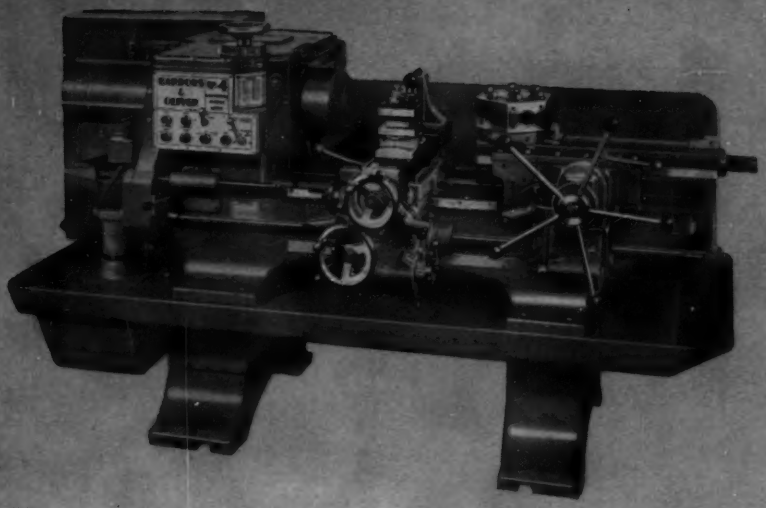
Known as the Sixty Series, high-speed precision lathes use a single lever to give one-motion control and thereby reduce spindle control time and increase productive time.

According to manufacturer, the



AUTOMATIC WELDING MACHINE, with four-station in-line transfer, assembles automobile reinforcement plate to crossmember with 55 direct pulsation welds. Production rate is 165 pieces per hour—*Expert Welding Machine Co, 17144 Mt. Elliott Ave, Detroit 12, Mich*

MORE DATA? Circle 73, inside back cover



RAM TYPE TURRET LATHES		
Size	Bar Capacity	Swing Over Bed
No. 1 Geared Electric	5/8″ or 13/16″	11-1/2″
No. 2 Geared Electric	1″ or 1-1/4″	13-1/2″
No. 3 Universal	1-1/2″ or 2″	15-1/2″
No. 4 Universal	2″ or 2-1/2″	18-1/4″
No. 7 Universal	2-1/2″, 3″ or 4-1/2″	21-1/2″
SADDLE TYPE TURRET LATHE		
No. 21 Universal	2-1/2″, 3″ or 4-1/2″	21-1/4″

BARDONS & OLIVER

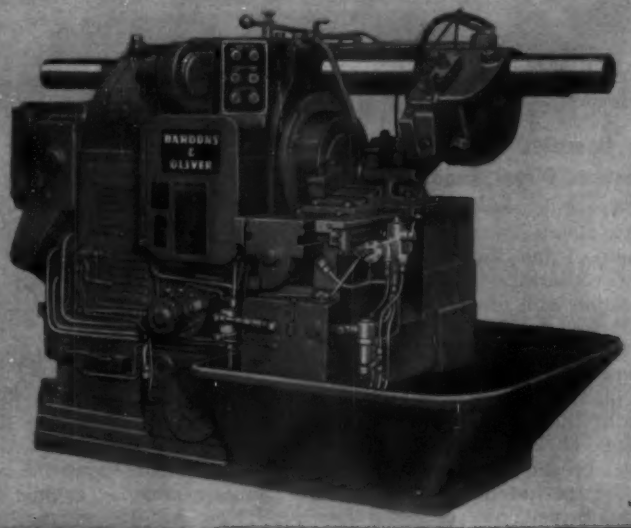
Turret Lathes . . . .

Each of the six Turret Lathes listed is a completely different machine, designed specifically for one range of work. All units on each machine, including the cross slide and carriage, and the turret slide and saddle, are "sized" for a particular work range. Thus adequate strength and rigidity is provided, maximum productive capacity is offered, and at the same time minimum operator effort is required. A complete line of tooling and attachments is available for each size of machine.

Cutting-Off Lathes

The Cutting-Off Lathes are designed to chamfer, form and cut off pipe, tubing, or bar stock with maximum efficiency. The number of pieces produced per hour often equals or exceeds that of much more expensive and complicated multiple spindle machines. Automatic loading tables, chamfer attachments, forming attachments, and automatic unloading devices are available for all sizes of Cutting-Off Lathes. These lathes are built as fully automatic, semi-automatic or hand operated.

CUTTING-OFF LATHES	
Size	Capacity
No. 32	2″
No. 33 and 34	3″, 4″ and 4-1/2″
No. 35 and 36	5-1/2″ and 6-5/8″
No. 38 and 39	8-5/8″ and 9-5/8″
No. 312 and 314	12-3/4″ and 14″
No. 316	16″



BARDONS & OLIVER

BARDONS & OLIVER, INC., 1133 WEST 9th ST., CLEVELAND 13, OHIO

Manufacturers of Turret Lathes and Cutting-Off Lathes

CIRCLE 257 READER SERVICE CARD

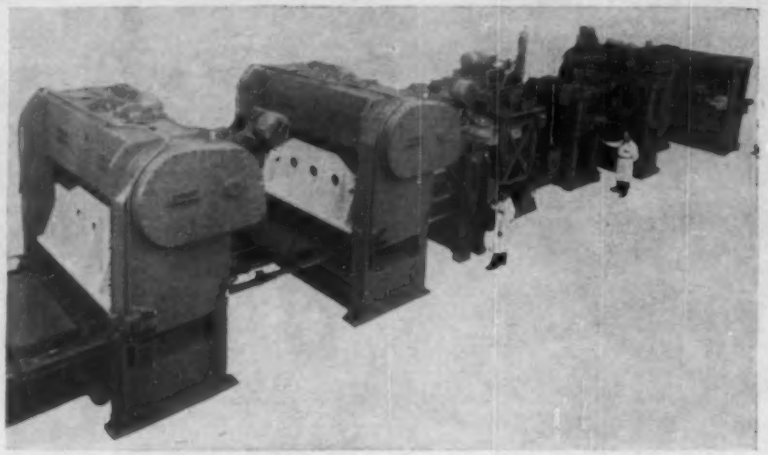
new series is an entirely new design offering five firsts for greater production, accuracy, and durability: Single lever starts lathe spindle and selects any speed within range up to 4800 rpm. Same lever will change speed during operation or instantly stop or reverse spindle. Stops may be set for repeating selected speeds on duplicate work.

Double-bevel bed positively centers tailstock in alignment with headstock. Spindle is assured true roundness and rigidity by large diameter super-precision ball bearings fitted to in-line ground mountings. All mating slides of compound rest are machined from steel, then fully hardened and ground. Uneven or non-rigid floor cannot distort lathe.

Collet size is 1⅛ in.

Rivett, Inc, Brighton 35, Boston, Mass

MORE DATA? Circle 74, inside back cover



WASHING MACHINE CABINETS are produced at a rate of 300 per hour in this automatic line which destacks the sheets, blanks, punches, flanges, U-bends, embosses and spot welds corner gussets, top braces and struts—*Taylor Winfield Corp, Warren, Ohio*

MORE DATA? Circle 75, inside back cover

Air Operated Hardness Tester Features Direct Reading Gage

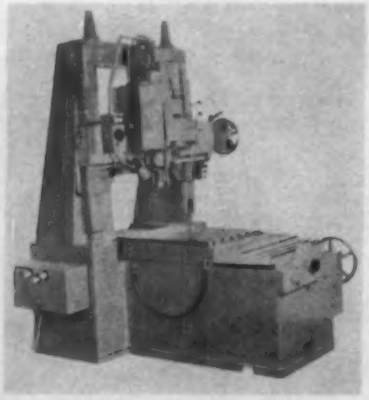
Air-O-Brinell metal hardness testing machine incorporating a direct reading Brinell hardness gauge combines accurate, foolproof load application with simultaneous read-out of Brinell hardness level, according to manufacturer.

Positive load application is assured, since the pressure gage at the top of the unit, graduated in kilograms of Brinell load, shows the exact pressure that will be applied before the test is made. To use the Air-O-Brinell, the operator simply adjusts the air pressure regulator valve until the desired Brinell load is indicated on the gage.

Machine operates on a small air supply of 1.2 cu ft per minute at pressures above 65 psi. Load application is maintained to within an accuracy of ±1%. The large gage mounted in the head of machine is calibrated for standard Brinell loads of 500, 1000, 1500, 2000, and 3000 kg. Air-O-Brinell is available in two standard models, with a vertical clearance from anvil to ball of nine or sixteen inches.

Tinius Olsen Testing Machine Co, 9304 Easton Rd, Willow Grove, Pa

MORE DATA? Circle 76, inside back cover



Improved Hauser Jig Borer Has Added Power, Speeds, Rigidity

Improved version of the Hauser No. 5 jig borer, made in Switzerland, is heavier, more powerful and has a greater range of spindle speeds.

New machine weighs 7700 lbs, an increase of 1100 lbs over the model it replaces. The base, table, boring head and other parts have been beefed-up for greater rigidity. Additional table supports now make it possible to position a 1300-lb casting.

Spindle is powered by a 4-hp instead of a 3-hp motor which provides infinitely variable speeds in two ranges: 10 to 430 rpm and 50 to 2000 rpm. Main spindle feed is reversible for tapping.

Tools are clamped automatically to the correct torque by raising the quill to the highest position. An additional knob for fine-setting the last tenth is said to eliminate the problem of tapping in the handwheel for fine adjustment.

Carl Hirschmann Co, Inc, 30 Park Ave, Manhasset, LI, NY

MORE DATA? Circle 77, inside back cover

VERTICAL CONVEYOR-TYPE washing machine, designed for the inter-process cleaning of small stamped and forged parts, washes a 300-1500 lb work load each hour. With its 11 foot vertical conveyor, only 16 square feet of floor space is required—*Ransohoff, Inc, 50 Ford Blvd, Hamilton, Ohio*

MORE DATA? Circle 78, inside back cover

On-the-spot deliveries of ALCOA ALUMINUM FASTENERS!

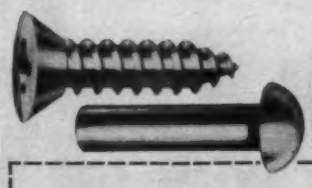
Need aluminum fasteners fast? That's why there's a local distributor of Alcoa® Aluminum Fasteners in your Yellow Pages. That's why he maintains full stocks of Alcoa Aluminum bolts, nuts, rivets, machine screws, wood screws, sheet metal screws, washers—anything you need in standard types and sizes. That's why you can telephone *any* time and get quick delivery, unsurpassed service.

You'll save time. You'll save money—lower production costs. Alcoa Aluminum Fasteners offer many advantages. They're corrosion resistant, won't discolor the finished product. They're free of burrs, with full threads. They're made in fully heat-treated, high-strength alloys. You get full count —exactly what you order.

You can prove it easily. Call your local Alcoa distributor now! If you'd like more data, and samples, just mail the coupon at right.

ALCOA ALUMINUM

ALWAYS FASTEN ALUMINUM WITH ALCOA ALUMINUM FASTENERS



For exciting drama watch "Alcoa Presents" every Tuesday, ABC-TV, and "Alcoa Theatre" alternate Mondays, NBC-TV

Aluminum Company of America
2000-F Alcoa Building, Pittsburgh 19, Pa.

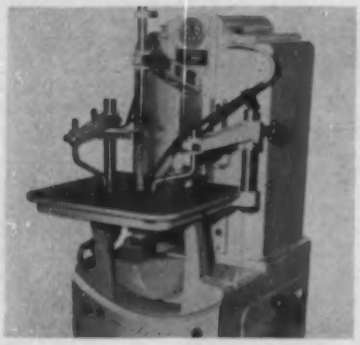
Please send me complete specification data and samples of Alcoa Aluminum Fasteners.

NAME_____ TITLE_____

COMPANY_____

STREET ADDRESS_____

CITY_____ ZONE___ STATE_____



German Filing and Sawing Machine Designed for Carbide Die Work

Thiel 115 filing and sawing machine, made in Germany, features infinitely variable speed and length of stroke, 9½-in. throat depth and a 18 x 18-in. work table which tilts in four planes through 15°.

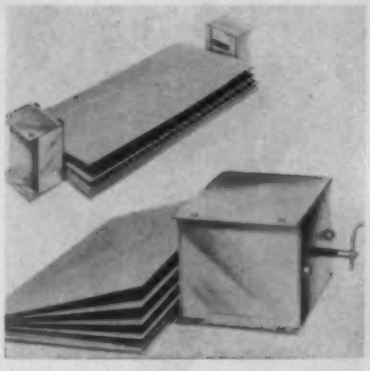
Both compression and tension type files can be used and files from 0.039 in. are available in all standard shapes. Work holddown, magnifying glass chip blower and lamp are provided as standard equipment.

The machine may be set up for machining carbides and other hard steels, using rotary or stationary files with sintered diamond chips. Straight sawing of hard materials is done with a round diamond file rotating at 12,000 rpm while reciprocating up and down. Feed can either be manual or by a subtable equipped with counterweights.

According to the manufacturer, the unit is particularly suited for small, internal work. The blade can be inserted into the hole and reclamped without cutting or welding.

Dist by United Machine Tool Co of Calif, 3620 Santa Fe Ave, Los Angeles 58, Calif

MORE DATA? Circle 80, inside back cover



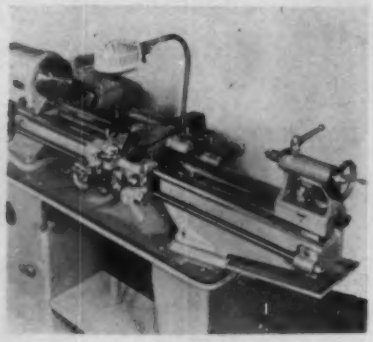
Magnetic Unit Separates and Floats Stacked Sheets of Steel

Magnetool separator handles 32 to 7 gage sheets. Designed to facilitate the feeding of round, square, or irregularly shaped sheets into presses, shears and similar production equipment, the unit reduces possibility of equipment damage due to multiple sheet feeding, and, according to manufacturer, substantially lowers production time. With adjustable separators, stacked steel sheets of virtually any thickness are magnetized so they repel each other and literally float in air, so that a machine operator can easily pick up one piece at a time

In addition to the adjustable unit, Magnetool offers 18 standard models, each pre-set to handle a specific gage of metal. Both standard and adjustable separators work individually or in pairs, and are of modular design so that two or more can be bolted together to accommodate any required stack height or width.

Multifinish Manufacturing Co, 26341 West Eight Mile Rd, Detroit 40, Mich

MORE DATA? Circle 81, inside back cover



Long Bed Delta 10-inch Lathe Has Two New Safety Accessories

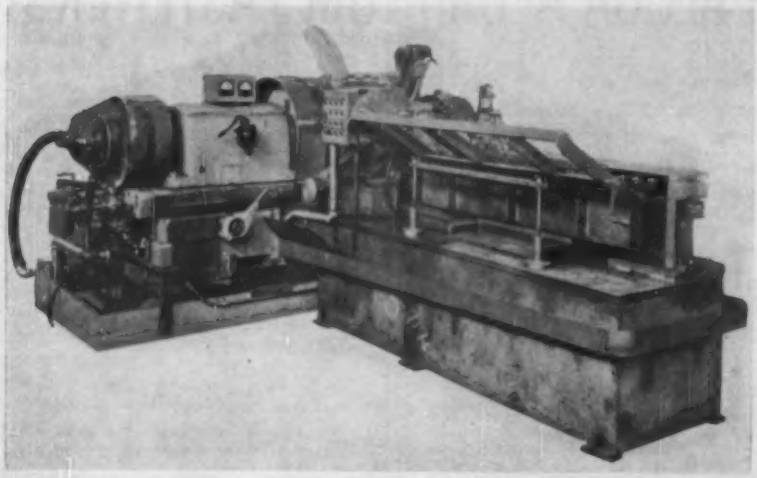
Long bed metal cutting lathe, with a capacity of 36 inches between centers, is particularly applicable for school shops because of two new safety accessories. They are: magnetic starter electrical disconnect switch kit which automatically shuts off motor when headstock cover is swung open; and a mechanical back gear lock-out kit which protects gears of headstock because it forces the operator to raise headstock cover before back gears can be engaged.

Model features variable-speed drive from 50-1500 rpm, ¾ in. collet capacity, and quick change gear box that provides a choice of 54 feeds or thread pitches.

The lathe is used with ¾ hp motor. Price, without bench, motor, and switch, is $722.50 fob factory.

Rockwell Manufacturing Co, Delta Power Tool Division, 471 N. Lexington Ave, Pittsburgh 8, Penn

MORE DATA? Circle 82, inside back cover



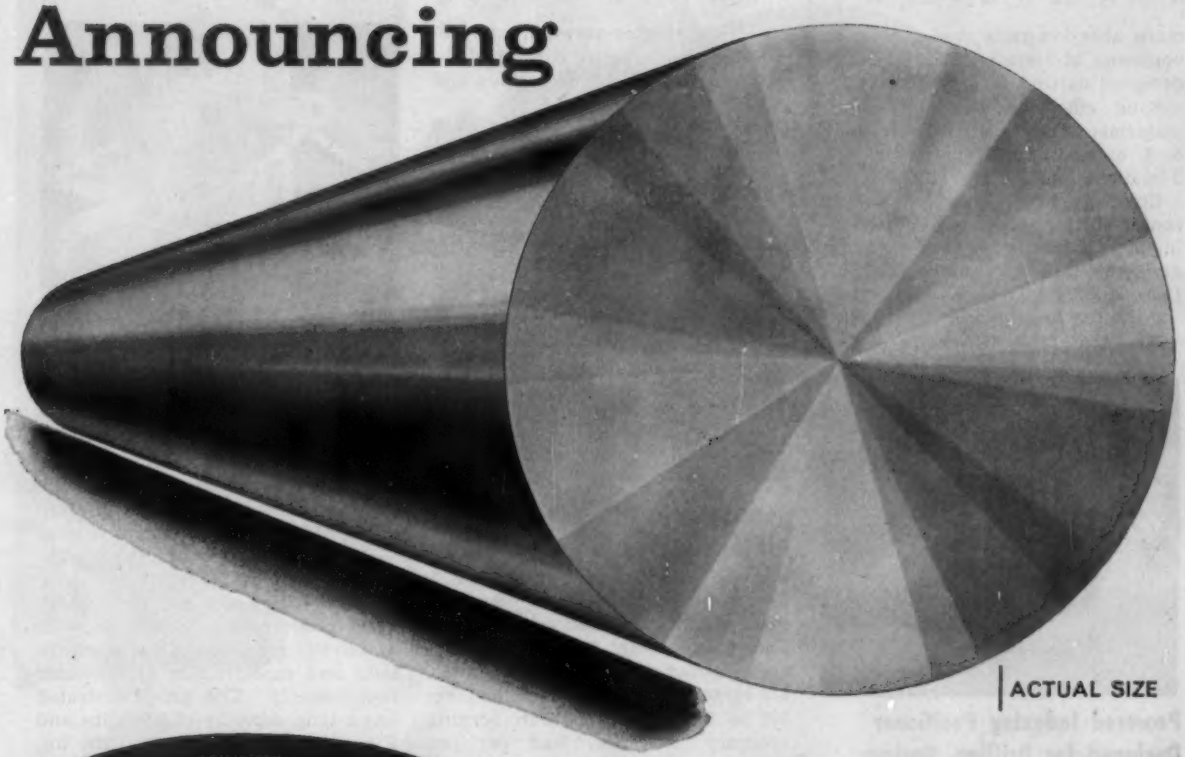
CHAIN-FEED DOUBLE-DISC GRINDER removes 0.015 in. of 1045 steel in one pass at a feed rate of 8 fpm. Size is held to 0.002 in. and parallelism is held to 0.001 in.—*Mattison Machine Works, Rockford, Ill*

MORE DATA? Circle 79, inside back cover

Vanadium End Mills Machine Hard, Abrasive Materials

New standard line designed for machining materials R_c 30-40 are made of vanadium HSS. They have higher red-heat hardness and substantially

Announcing



ACTUAL SIZE

STRESSPROOF®
STEEL BARS
WITH COPPER

In Diameters Through 4"

Five new sizes: 4", 3⅞", 3¾", 3⅝", 3½".

Same high strength as smaller diameters...100,000 psi yield.

Fast machining...83% of B1112.

Cost less than heat treated in-the-bar alloys.

Ideal for both production *and* maintenance applications.

No heat treating necessary

Available from your Steel Service Center

Ask for Helpful Data Bulletin #15. It tells the story of STRESSPROOF.

La Salle STEEL CO.

1416 150th Street
Hammond, Indiana

Name_____

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Company_____

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more abrasion resistance than conventional M-2 steel tools. Specially designed cutting face provides max cutting efficiency on prehardened materials. They are available in 2, 3, 4, and 6 flutes from ⅜ through 2 in. diameters.

Company has also added 4 flute center cutting miniature sizes starting at 1/32 in. dia, keyway and large diameters 2 in. and over with Sure-Lock shanks to its end mill line.

DoAll Co, Des Plaines, Ill

MORE DATA? Circle 83, inside back cover

Powered Indexing Positioner Designed for Drilling, Boring

Powered indexing positioner is a motorized trunnion for use on drilling, reaming, tapping or counterboring operations. It has 24 positive index stations from 0 to 360°.

Specs include: 0.0025-in. index tolerance, 36-in. swing, 25-in. cradle width, 48-in. cradle gap, 2000-lb capacity, 4-rpm cradle speed, 2-hp motor.

Johnson & Bassett, Inc, Production Tool Div, Worcester, Mass

MORE DATA? Circle 84, inside back cover

Furnace-Bond Aluminizing Process Produces High Coating Uniformity

Improved process developed especially for high temperature service applications is recommended for application on any Series 400 stainless steel, all carbon steels, and a variety of alloy steels. It may also be used with austenitic stainless steels. Aluminum coating is applied cold by means of mechanical spray equipment. It is furnace-bonded to the base metal at high temperatures in a controlled atmosphere to achieve a diffused alloy bond. Total buildup is held within the tight range of 0.002 to 0.005 in.

Advantages include more uniform coating in all areas—thickness, penetration, and microstructure; deeper penetration — deeper, denser alloy layer provides higher oxidation and corrosion resistance; greater hardness, giving better abrasion and erosion resistance; better control of dimensional change due to buildup and growth.

Wall Colmonoy Corp, 19345 John R St, Detroit 3, Mich

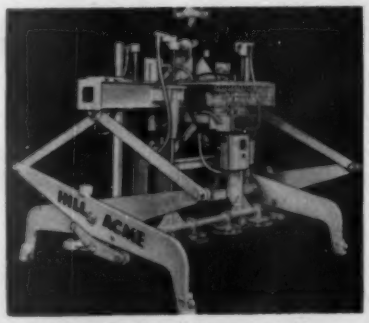
MORE DATA? Circle 85, inside back cover

German Lathe Offered For Instrument Use

LAS Lorch, made in Germany, is a precision leadscrew lathe for research and fine instrument work. Specifications are: 5/16-in. capacity, 5¼-in. swing, 11¼-in. center distance, 1/6-hp motor, 12 spindle speeds from 800 to 3000 rpm, 0.00012-in. turning accuracy, 0.005 in. feed per rev special feed of 0.0012 ipr.

Dist by R P Gallien & Son, 220 W 5th St, Los Angeles, Calif

MORE DATA? Circle 86, inside back cover



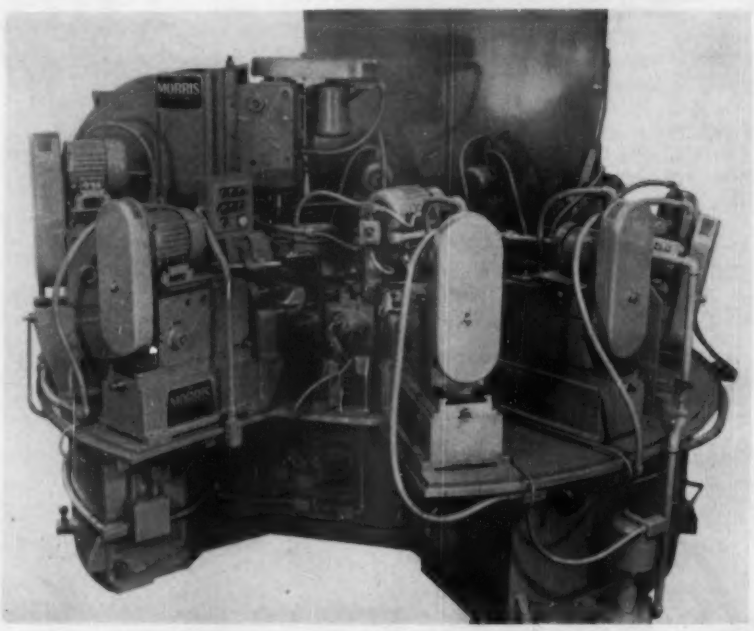
Sheet and Billet Lifter Handles Ferrous, Nonferrous Materials

Combination sheet and billet lifter handles single sheets, slabs, billets, or ingots. Multiple vacuum cups or scissor tongs are used as required. The tong action is automatic and face of material being handled is protected by supporting rollers attached to the tong arms.

These lifters are suited for handling nonferrous materials as well as ferrous metals, and are made in sizes and capacities to fit customer requirements. The unit illustrated has a tong capacity of 8,000 lbs and a vacuum lift capacity of 1,200 lbs, both with adequate safety factors.

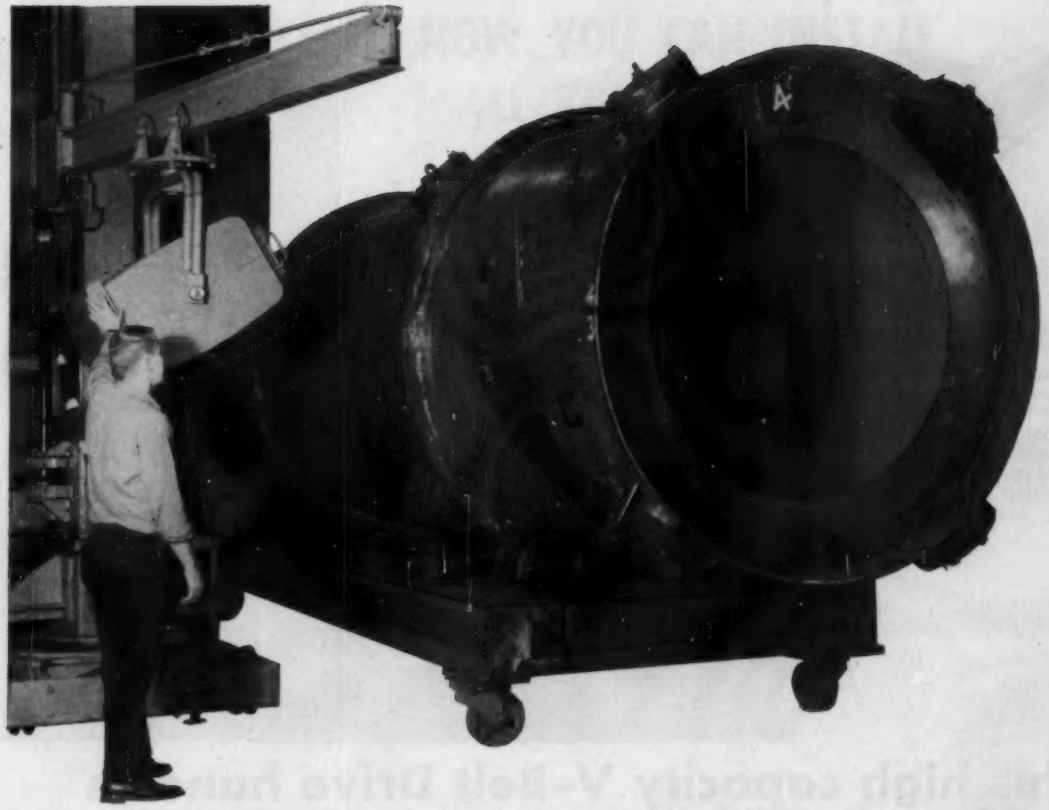
Hill Acme Co, 1201 West 65th St, Cleveland 2, Ohio

MORE DATA? Circle 87, inside back cover



HORIZONTAL ROTARY INDEX MACHINE uses a 36-in. dia table and 13-station automatic Geneva index to drill, ream and mill 260 rotors per hour. Center holes in both ends of the part are drilled simultaneously—*Morris Machine Tool Co, 2011 Eastern Ave, Cincinnati 2, Ohio*

MORE DATA? Circle 88, inside back cover



Undersea nest for a talented metal bird

This is the firing tube of the Navy's Polaris missile, made by Consolidated Welding and Engineering Company, Chicago, Ill. Every weld must be flawless. To make sure, more than 100 radiographs are made on each assembly.

Made of HY-80 plate with monel inserts, this firing tube presents difficult problems in welding dissimilar metals. But radiography, with Kodak Industrial X-ray Film, Type AA, checks the entire assembly for discontinuities.

Radiography provides the means of "seeing" internal conditions and supplies a lasting record of what is seen. It gives producers of welded products and of castings a means of making sure only high-quality work is delivered.

Would you like to know how radiography can help you? See an x-ray dealer or write us to have a Kodak Technical Representative call.

Read what Kodak Industrial X-ray Film, Type AA, does for you:

- Speeds up radiographic examinations.
- Gives increased detail visibility and easy readability at all energy ranges . . . because of high film contrast.
- Provides excellent uniformity.
- Reduces the possibility of pressure desensitization under shop conditions.

EASTMAN KODAK COMPANY
X-ray Division, Rochester 4, N. Y.

Radiograph of weld on missile firing tube.

Kodak
TRADE MARK

Cedarapids Super Commander Portable Crushing and Screening Plant, built by Iowa Manufacturing Company, Cedar Rapids, Iowa, produces up to 500 tons per hour of crushed and screened material in four different product sizes.

This high capacity V-Belt Drive handles

60% more power in 30% less space!

Higher Capacity of Gates Super HC V-Belt Drives solves complex product-development problem!

In developing a larger crusher, requiring more horsepower, Iowa Manufacturing Company was faced with the problem of transmitting 400 hp from a higher-speed engine in a space that had been just enough for conventional V-belts carrying 250 hp.

At the higher speeds, centrifugal force made it impossible to go to larger sheave diameters to accommodate larger belt sections. A wider span of belts was ruled out by Highway Department requirements, which restricted overall machine width to eight feet.

Iowa Manufacturing's designers solved their primary problem of transmitting 60% more horsepower with new Gates Super HC V-Belts.

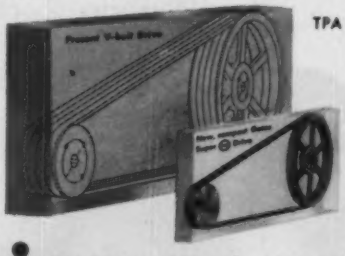
Because Super HC V-Belts have smaller cross section, use narrower and lighter-weight sheaves, pack higher hp capacity in a smaller 'package' than conventional V-belts, designers also succeeded in reducing drive weight, width and height — a decided bonus in equipment that must be moved frequently both on and off the highway.

Nation-Wide Engineering Service

There's a Gates Distributor nearby to show you how to reduce drive weight, space and cost with Super HC V-Belt Drives. With Super HC, sheave diameters can be reduced 30% to 50%, drive space up to 50%, and drive weight 20% or even more.

Ask your Gates Representative for your free copy of "The Modern Way to Design Multiple V-Belt Drives," or write to The Gates Rubber Company Sales Division, Inc., Denver, Colorado.

TPA 503A



The Gates Rubber Company, Denver, Colorado
Gates Rubber of Canada Ltd., Brantford, Ontario

Gates — *World's Largest Maker of V-Belts*

Gates Super HC V-Belt Drives

same hp capacity in smaller "package"

Heavy Duty Work Spindle Has Wide Range of Speeds

Bench model work spindle delivers continuous heavy duty service on secondary operations such as polishing, burnishing, lapping, spinning, reaming, deburring, filing of small parts. It is ball bearing equipped and permanently lubricated.

There is a 1-in. diameter through-hole in shaft. Spindle nose accommodates No. 5C draw-in collets up to 1 in. diameter round, ⅞ in. hex, and ¾ in. square. Variation in spindle speed ranges from 180-3600 rpm, and selection can be made for one-only speed, a wide range of two-speed combinations, and also four-speed combinations.

Standard Electrical Tool Co, 2480 W Sixth St, Cincinnati 4, Ohio

MORE DATA? Circle 89, inside back cover

Pneumatic Grinder Equipped With Spindle Extension

Model 1FL3 grinder features a spindle extension for improved visibility of work and better control with two-handed operation. It has a four-vane rotary air motor with a speed of 28,000 rpm and spindle accuracy of 0.0005 maximum runout on all collet-type grinders. The grinder measures 1 5/16 in. OD, 7⅝ in. long and weighs 16 oz.

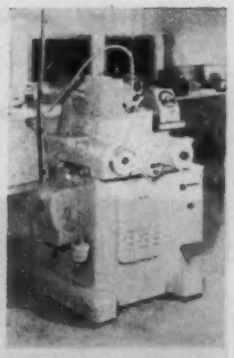
Doeden Tool Corp, Sherwood, Ohio

MORE DATA? Circle 90, inside back cover

NOW YOU CAN INSTALL ALL YOUR MACHINES

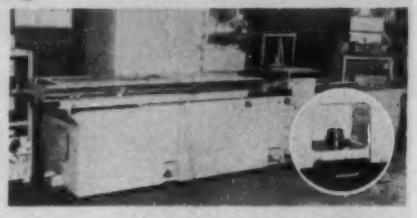
in a low cost "Do-It-Yourself" way by using Air-Loc® 4·17·4

- to reduce vibration and noise
- to permit easy shimming
- to hold precision level



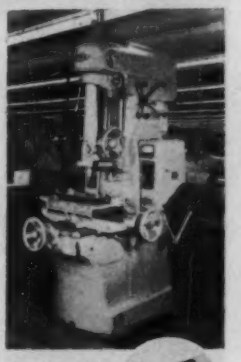
Taft-Peirce 6" Rotary Surface Grinder is on AIR-LOC to reduce transmitted vibration.

You need no bolts or cement with AIR-LOC. Many firms keep sheets of AIR-LOC on hand and cut mounts to correct size. When you move machines, you can re-use your AIR-LOC mounts, which have such great resilience that they do not take a permanent "set".

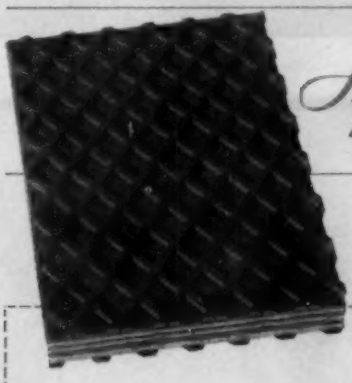


Cincinnati Planer stays level to .0005" installed on 8 AIR-LOC mounts. Leveling screws for precision adjustment.

Air-Loc® 4·17·4 . . . is an engineered mount that can be loaded to 1,000 p.s.i. It is sold in 18" x 36" sheets, easy to cut with a saw. To *maintain* the precision which is built into your machines, plan now to install them the easy AIR-LOC way.



Moore Jig Borer installed on AIR-LOC mounts without bolts or cement.



Air-Loc® 4·17·4

You get a permanent precision installation with patented AIR-LOC mounts that *Resist* oil, water and alkali, *Permit* easy leveling, *Eliminate* need for bolts or cement, *Hold* machines in place, *Reduce* transmitted vibration from the floor.

Return Coupon for Air-Loc Samples and Booklet.

AIR-LOC DIVISION
Clark-Cutler-McDermott Company
Franklin, Massachusetts

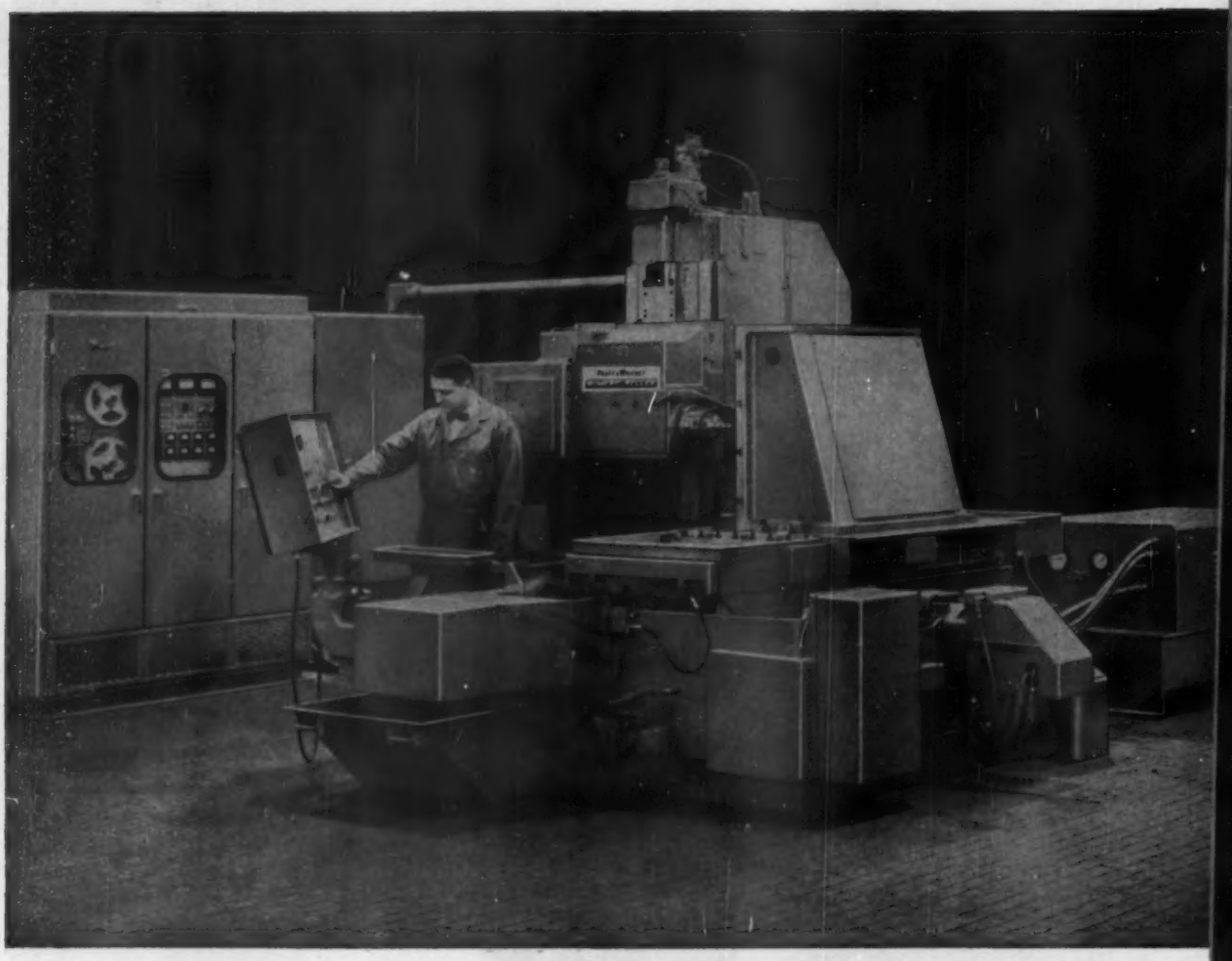
NAME..... TITLE.....
(Please Print)

COMPANY.....

ADDRESS.....

CITY..... ZONE..... STATE.....

ACCURACY



PER-PIECE PRODUCTION TIME CUT 33% . . . by machining these aluminum computer housings on a Numeric-Keller. Each piece required 12 pockets milled and 72 holes drilled. Scrap loss to date: zero!

ONLY 21.5 HOURS . . . were needed to machine this complicated tool steel missile part on a Numeric-Keller. Machining involved 3 roughing and finishing contour cuts and 4 roughing and finishing pocket milling cuts.

3-DIMENSIONAL MILLING UNDER TAPE CONTROL . . . is demonstrated by this vision block for a super-modern military tank. Geometry is quite complex. Tape was prepared using both computer and hand computations.

ASSURED...

...PLUS REVOLUTIONARY ADVANCES IN MACHINING SPEED, EFFICIENCY and VERSATILITY with the new

NUMERIC KELLER

TOOLING COSTS and LEAD TIME CUT AS MUCH AS 75% . . . because the P&W Numeric-Keller is equipped for continuous-path milling under the direction of a tape-reading numerical control system. Models, templates and other costly, complicated tooling are eliminated!

EXTREME ACCURACY . . . with overall production easily held to ± .001". Piece-to-piece reproduction accurate to "tenths" is possible with controlled cutter selection.

UNUSUAL VERSATILITY . . . with more different types of jobs done faster and better. Short and long runs are handled with equal efficiency. Using tape, changeover is fast and easy, with minimum time lost between jobs.

MACHINE UTILIZATION IS GREATLY INCREASED . . . because more time is spent making chips, with less time needed for setup, fixturing and other non-productive operations. Similarly, man-hours are made more productive.

MACHINING TIME IS SLASHED . . . because tape control means maximum speeds and feeds programmed through all phases of the machining cycle. Optimum machining practice at all times also means finer surface finishes.

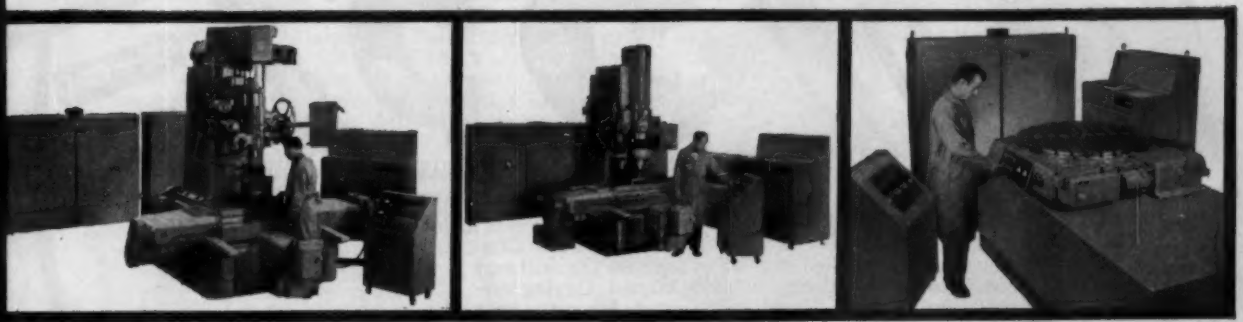
SEND NOW FOR THE CASE-HISTORY FACTS . . . that show how the P&W Numeric-Keller has saved *HOURS* of setup, tooling and machining time on dozens of jobs like the 3 examples shown on the facing page. See how this revolutionary machine can produce equally important savings on the toughest milling jobs in YOUR plant. Write today for your copy of Circular No. 624, that includes Job Analysis Sheets to give you the dollars-and-cents facts on Numeric-Keller savings. Pratt & Whitney Company, Inc., 11 Charter Oak Blvd., West Hartford, Connecticut.

100th Anniversary 1860 1960

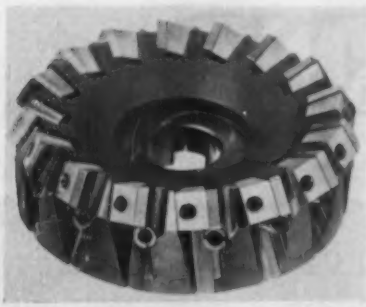
PRATT & WHITNEY®

FIRST CHOICE FOR ACCURACY

MACHINE TOOLS • GAGES • CUTTING TOOLS



OTHER P&W NUMERICALLY CONTROLLED MACHINE TOOLS . . . include the Jig Borer, Vertical Precision Hole Grinder, and Precision Rotary Tables. Providing settings accurate to .0001", made automatically from data supplied by punched tape or operator keyboard, the Jig Borer and Hole Grinder combine toolroom precision with production-line speed and ease of operation. Equally efficient for short- or long-run production work. Ultimate in speed plus precision in circular spacing, graduating, and angular positioning, the Pratt & Whitney Numerically Controlled Rotary Table provides automatic settings accurate to 5 seconds of arc!



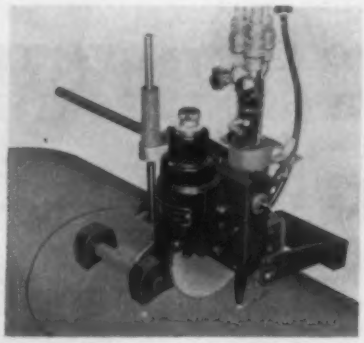
Milling Cutters With Throwaway Inserts Designed for Finishing

Line of milling cutters with throwaway carbide inserts is designed for finishing as well as roughing operations. Cutters have adjustable tapered pins to provide axial support for individual inserts. Because each insert can be adjusted axially to ten-thousandths of an inch, inserts with commercial tolerances can be used for milling cutters with face runout.

Pins have tapered bottom sections that are locked into the cutter body by differential screws. The top section of each pin is a straight-sided constant-rise cam with a maximum eccentricity of 0.030 in. Milling cutters with the adjustable pin are available in various lead angles with diameters 5 in. and larger.

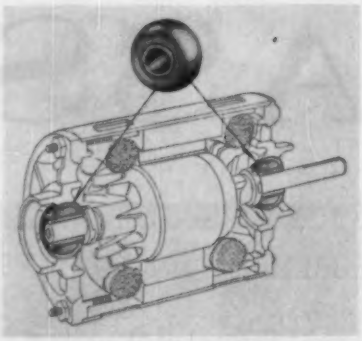
Wesson Co, 1220 Woodward Heights Blvd, Detroit 20, Mich

MORE DATA? Circle 91, inside back cover



MECHANIZED HAND CUTTER for cutting round openings in tanks and large diameter pipe makes straight, irregular, or circular cuts in flat plate with equal speed and accuracy. Oxyacetylene torch, powered by a 110-v variable speed motor, makes it adaptable to cutting varying thicknesses—*Steffan Mfg Corp, PO Box 275, Salem, Ohio*

MORE DATA? Circle 92, inside back cover



Randall Introduces Permanently Lubricated Midget Bearing

Series 0049 of new self-aligning bearing, specially designed for small fractional motor applications, is available for shaft sizes of ¼, 5/16, ⅜, and 7/16 in. This unit is a permanently lubricated bearing with a sintered bronze bushing.

Design offers a substantial advantage over old type sleeve bearings because it provides a bearing which is maintenance free; it eliminates the need for oil lines, reservoirs, oil cups, wicking, oil slingers, and catchers. Tested over a five-year period, this bearing gave top performance

ACCURACY ASSURED...

CONVENTIONAL GAGES

Thread Plug and Ring Gages

Pipe Thread Gages

Roll Thread Snap Gages

Adjustable Limit Snap Gages

Cylindrical Plug and Ring Gages

Precision End Measures

Available in complete lines for all your applications, P&W Conventional Gages are unequalled in quality, because the skill and care that goes into making them cannot be copied. Gaging surfaces are precision lapped . . . not just ground. Expertly heat treated for superior hardness and dimensionally correct, P&W Conventional Gages insure dependable, accurate inspection plus longer wear life.

100th Anniversary 1860 P&W 1960

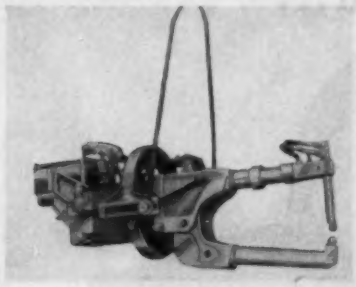
FIRST CHOICE FOR ACCURACY PRATT & WHITNEY

CIRCLE 265 READER SERVICE CARD

with no measurable depletion of the lubricant.

Randall Graphite Bearings, Inc, Greenlawn Ave, Lima, Ohio

MORE DATA? Circle 93, inside back cover

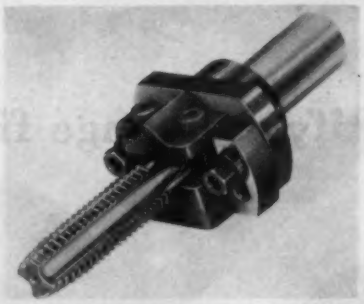


Portable Welding Gun Operates At 18,000 amp, 1350 lb Pressure

Model 510, latest addition to the Aro line of portable spot welders, is air operated, fully automatic, water cooled, and will weld from the lightest gage up to 2 x 3/16 in. Unit is equipped with gyroscopic suspension for easy rotation in all directions.

Aro Spot Welders, Div, Guthrey Machine Tool Corp, 38-31 Crescent St, Long Island City 1, NY

MORE DATA? Circle 94, inside back cover



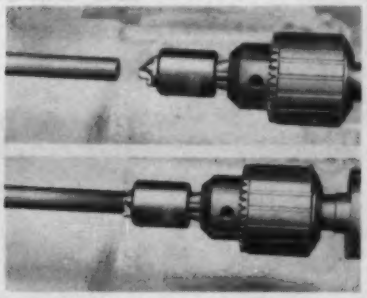
Non-Releasing V-Jaw Tap Holder Speeds Screw Machine Setups

New slip-in holder that will take either extended or close-held taps offers automatic, axially perfect tool alignment. It eliminates cutting off tap shanks, an operation often necessary with other types of bushing or collet-type holders. Uniform seating is maintained and tap is firmly secured by means of a balanced pressure locking assembly.

Spring return assembly is totally enclosed to prevent chips or dirt from snagging the free float of the axial movement control spring. Since side pressure is also eliminated, the spring remains free-floating even when adjusting for spindle misalignment. Because of adjustable V-jaw each holder unit services a wide range of tap sizes.

Brookfield Inc, Stoughton, Mass

MORE DATA? Circle 95, inside back cover



Cutting Tool Combines Three Steps in Finishing Tube Ends

TuBurr combines three operations in one for finishing tube ends in screw, multiple spindle, and tube finishing machines. It chamfers both OD and ID faces all in one stroke.

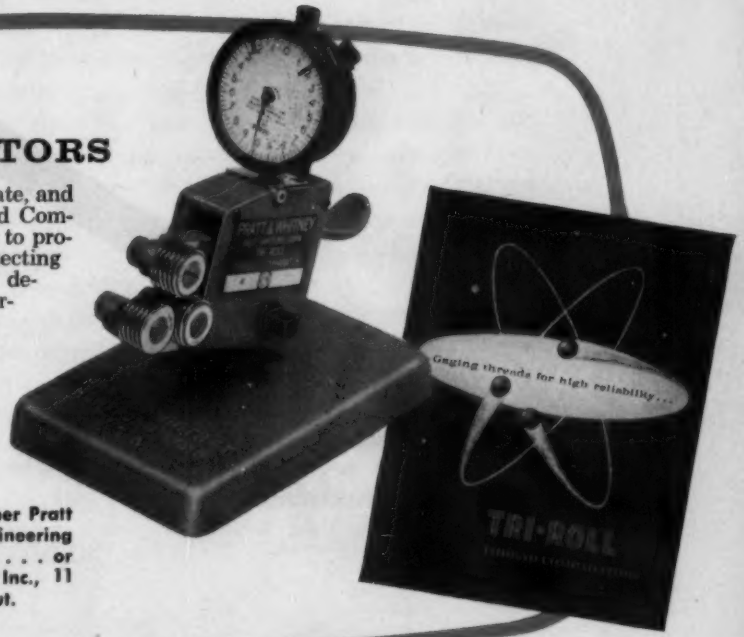
Spindle travel toward the tube automatically centers the cone-shaped tip in the tube end, thus eliminating any misalignment. Continued spindle travel retracts the cone into the tool body, exposing the blade for

with PRATT & WHITNEY GAGES

TRI-ROLL
THREAD COMPARATORS

Fast and easy to operate, extremely accurate, and unusually versatile, P&W Tri-Roll Thread Comparators can be used with full-length rolls to provide a complete *functional* check . . . detecting errors in lead, angle, pitch diameter, and deviation from true helical path. Using interchangeable single-rib rolls, they provide a *critical* check of pitch diameter . . . duplicating the precise 3-wire method *on a production basis!*
For a complete discussion of the Tri-Roll Method for profitable control of precision threaded parts production, ask for P&W Circular No. 606.

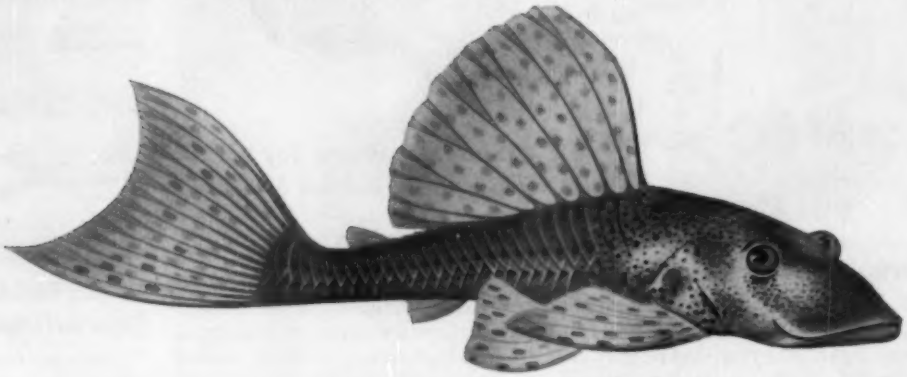
For complete information about these and other Pratt & Whitney Gages — and for application engineering service — call your Local P&W Branch Office . . . or write direct to Pratt and Whitney Company, Inc., 11 Charter Oak Blvd., West Hartford, Connecticut.



"JOB ENGINEERED" MACHINE TOOLS • GAGES • CUTTING TOOLS

CIRCLE 266 READER SERVICE CARD

To identify a strange fish...



you call in an *ICHTHYOLOGIST*

(specialist in fish life)

to cut production costs...

you call in *LINCOLN*

(specialists in arc welding)

BECAUSE of high operating costs a Maryland barge builder had trouble meeting competitive prices. The LINCOLN Field Engineer recommended a semi-automatic "Squirt" welder. On heavy plate it was four times faster and reduced overall costs due to reduced plate preparation and cleaning time.

As a matter of fact, right there is a good reason for doing business with LINCOLN. Cost reduction is a sort of religion at LINCOLN where production costs have dropped as much as 50% in the last 20 years. It's the result of LINCOLN'S world-famous cooperation between employees and management where everybody gets paid according to his own contribution to the company's goal—superior products and service to you at continually decreasing costs.

That's why we say it's a good idea to do business with LINCOLN where arc welding is a specialty and cost reduction comes to you as a "plus" at no charge.

To learn how LINCOLN can be of service to you, write today

THE LINCOLN ELECTRIC COMPANY
Dept. 1610 • Cleveland 17, Ohio

LINCOLN WELDERS

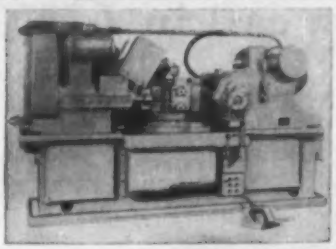
ALL ENDS OF PARTS
Completely Finished
"1·2·3"
ON THE
GOSS *and* DeLEEUW
Automatic Chucking Machine
in 1 SET-UP

This recent Goss & DeLeeuw development has already received universal acclaim as an outstanding achievement.

In speed, ease of tooling and precision finishing, the "1-2-3" chucker provides engineering advantages which result in vastly greater production at a fraction of parts' costs by other methods.

Easy, fast change-over from job to job makes this machine ideal for short-run requirements. Sturdy construction, power and speed make its advantages also apparent on long runs.

"1-2-3" means ability to handle work requiring machining operations on one, two or three ends simultaneously or in sequence — a method exclusive with Goss & DeLeeuw and offered on this machine.



Illustrated literature available promptly on request. Send samples of your work for time and cost estimates.

GOSS & DeLEEUW
QUALITY PRODUCT-QUANTITY

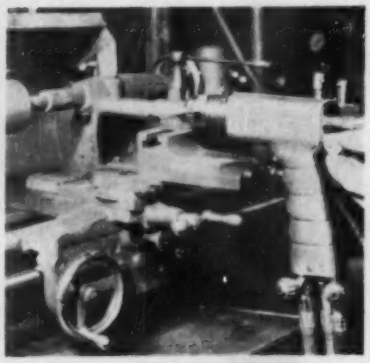
GOSS *and* DE LEEUW
MACHINE COMPANY, *KENSINGTON, CONN., U.S.A.*

cutting. Upon release of spindle pressure, the cone returns to original position, out over the blade.

Blades are interchangeable and available for any angle or degree of chamfer. Capacities range up to 2½ in. ID tubing on standard models.

Cogsdill Tool Products, Inc, 12980 West Eight Mile Rd, Oak Park 37, Mich

MORE DATA? Circle 96, inside back cover



Powder Metal Spraying Unit Claimed To Be 95% Efficient

Model D Spraywelder powder metal spraying unit is said to have a 95% deposit efficiency and a spray rate of over 12 lbs per hr. It is also 20% lighter than Model C-2 which it replaces.

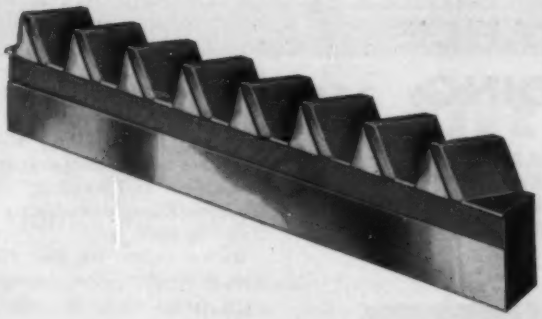
It consists of a pistol, a hopper and a control panel. Mounted on the panel are powder hopper with carburetor plus an air filter and regulator. The unit uses oxygen, acetylene and air fed through rubber hoses to the pistol, and can operate continuously for 1 to 1½ hours.

Wall Colmonoy Corp, 19345 John R St, Detroit 3, Mich

MORE DATA? Circle 97, inside back cover

"I like this machine. It needs me."

Everybody knows that
National Tool Company
makes rotary herringbone
gear shaper cutters



But did you know we make
rack-type herringbone
gear shaper cutters

and more special cutting tools of all kinds
than any other tool manufacturer?

For more than half a century National Tool Company has supplied high quality precision cutting tools to the metal working industry. When your job requires special cutting tools call your National Tool representative. His assistance is yours for the asking whether you're interested in one *special* tool or a complete tooling program.

NATIONAL Tools CLEVELAND

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TOOL CO.
Cleveland 2, Ohio

Representatives in major industrial centers

New FREE Catalog

To National Tool Co., 11200 Madison Ave., Cleveland, Ohio

Please send NEW 92 page catalog showing National Tool Company's complete line of *special* tools for the metal-working industry.

Name_____
Position_____
Company_____
Address_____
City_____ Zone_____ State_____

SPEED AND FLEXIBILITY

— with cost-cutting Vertical Shapers

Easily set up and using the simplest tooling, the CHOMIENNE M-5" with its combination of longitudinal, transverse and rotary table movements, angular ram adjustment and ram speeds up to 270 strokes per min. solves production "problems."

Also available —
Vertical Shaper, 12" with 28¾" Rotary Table, 5 HP motor.
Horizontal Shapers, plain and universal 12" to 30" stroke, 2 to 10 HP motors

5" Vertical Shaper
12½" Rotary Table
2 HP motor

austin industrial corporation

76-F Mamaroneck Avenue White Plains, New York

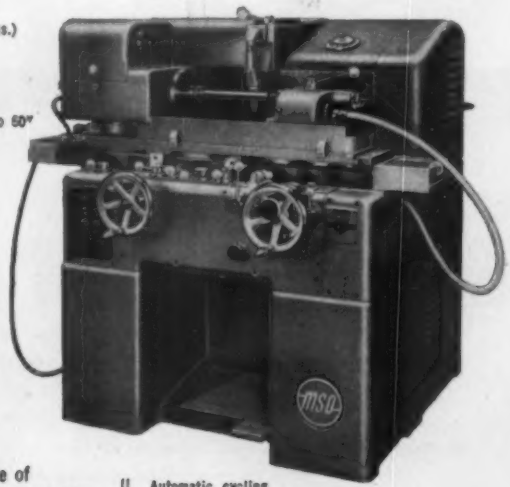
CIRCLE 284 READER SERVICE CARD

MSO Since 1865

FOR MORE PROFITABLE GRINDING

For automatic production in plunge or traverse grinding MSO Hydraulic Grinders offer ease and speed of operation with single lever control, automatic cycling including variable spark-out to fine finish and preset size — against positive stop (repeat accuracy .00004") or by electric gauge.

Model FH-200 (Illus.)
Swing 10"
Model FH-100
Swing 7"
Model FH-300
Swing 13¾"
Grinding lengths to 60"



MSO offers a complete line of precision grinding machines with features such as:

Automatic cycling
+ Precimatic sizing
+ Electronic Match Grinding

WRITE FOR LITERATURE ASK FOR REFERENCES

When only the best will do, check MSO first

austin industrial corporation

76-F Mamaroneck Avenue White Plains, New York

Ultrasonic Soldering Iron Joins Materials Without Flux

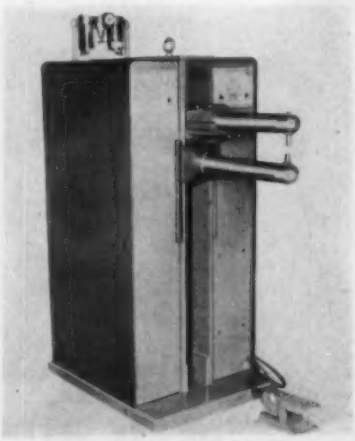
Ten-watt soldering iron which weighs eight ounces is said to solder a wide range of materials without flux.

It can be used for soldering semiconductor materials as well as metals like aluminum, magnesium and their alloys. Oxide films are removed by the ultrasonically activated tip and the molten solder then forms an intimate bond with the surface of the metal without using flux.

Operating on 115-v, 60-c power, unit uses a high temperature ceramic transducer and standard replaceable General Electric soldering iron tips. Price is $249.

Gulton Industries, Inc, 212 Durham Ave, Metuchen, New Jersey

MORE DATA? Circle 98, inside back cover



Spot Welder Converts To Variety of Operations

Uni-strut spot welder converts to foot, air rocker or air press operation without the necessity of drilling holes, welding or similar modifications.

Adjustable throat design enables the user to move the arms of the

. . . *when* THOMSON RIVETS

replace 4 bolts and nuts in double-tubular joints of Wallace's Fold 'n' Kot!

Wallace Products, Inc., Bellmawr, New Jersey, manufacturers of steel and aluminum products, is a long-time user of Thomson rivets for dependable fastening of portable cots and tables. Latest step in their product-improvement and cost-reduction programs was the rewarding switch from hand-applied bolts and nuts to machine-set rivets for the critical joint pictured above. The Thomson combination of tubular rivets and automatic rivet setting machines provided the superior fastening strength, assembly speed and automatic quality control inherent in riveting.

Drastic cost reductions resulted when Wallace Products switched to Thomson rivets (S-1844, 34/16") set with Thomson automatic riveting machine (Style 148).

Seventy-five years' experience in solving fastening problems is the plus you get when J. L. Thomson Mfg. Co. becomes your source of rivets and machines. More than 8,000 rivet specifications and more than 200 machine models give you standard answers to special or routine fastening requirements.

Selection of the right rivet-and-machine combination is made easy by a get-together with your nearby Thomson Fastening Man. He's listed in the Yellow Pages. Another valuable source of information is Thomson's new handbook. The coupon at right, attached to your company's letterhead, will bring it to you.

Judson L. **THOMSON** Mfg. Co.
WALTHAM 54, MASSACHUSETTS
Thomson (Canada) Rivet Co. Ltd.
Gananoque, Ontario

Judson L. Thomson Co. 626 Sawyer Rd., Waltham, Mass.

- Please rush your new handbook "Cost-Cutting Facts about Fastening with Rivets".
- Name _____ Title _____
- Company _____
- Address _____
- City _____ Zone _____ State _____

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"USING 'POP' RIVETS IS LIKE ADDING EXTRA MEN TO OUR PRODUCTION STAFF"

says G. F. Williams, Plant Manager at Industrial Cab Co., Salem, Mass. "And there seems to be no end to the number of jobs which can be done better and quicker with these blind fasteners.

"Because of the wide grip range of "POP" Rivets, problems in joining a variety of material thicknesses have been eliminated. Our fastener inventory has been minimized and instruction time reduced because of the simple installation procedure."

"POP" Rivets are making equivalent savings on boats, metal furniture, appliances, refrigeration and air conditioning equipment, pre-fab houses, truck and trailer bodies and hundreds of other products.

Investigate now the ease with which your company can enjoy the advantages of using "POP" Rivets. Call or write for your personal copy of our new catalog or order the introductory Kit today.

NEW!
LET THIS KIT INTRODUCE YOU TO "POP" RIVETS

The easy way to get started, this introductory Kit contains approximately 240 "POP" Rivets in various lengths and materials together with a hand setting tool. Complete with instructions and application hints. Order today and start saving on fastener costs!

$19.95 postpaid

"POP" RIVET DIVISION
UNITED SHOE MACHINERY CORPORATION
476 RIVER ROAD, SHELTON, CONN.
REgent 5-3391

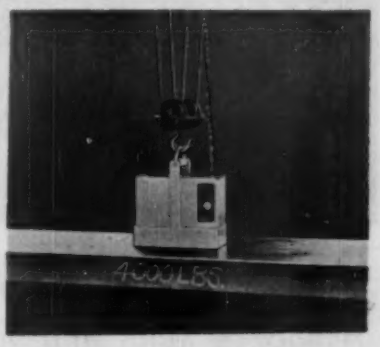
UNITED
"POP"
RIVETS

welders. Continuous heat control is infinitely variable from 100 down to 20%. The Series 300 welder can be connected to either 220 or 440-v power without replacing any component or sacrificing any operating qualities of the machine.

Ejector holders allow slipping a tube or box over the horn for welding with an inside dimension as small as three inches. New Class H insulated transformer, with a test voltage of 4000-v, will stand temperatures over 500 C.

Peer Inc, 1200 Milton St, Benton Harbor, Mich

MORE DATA? Circle 99, inside back cover



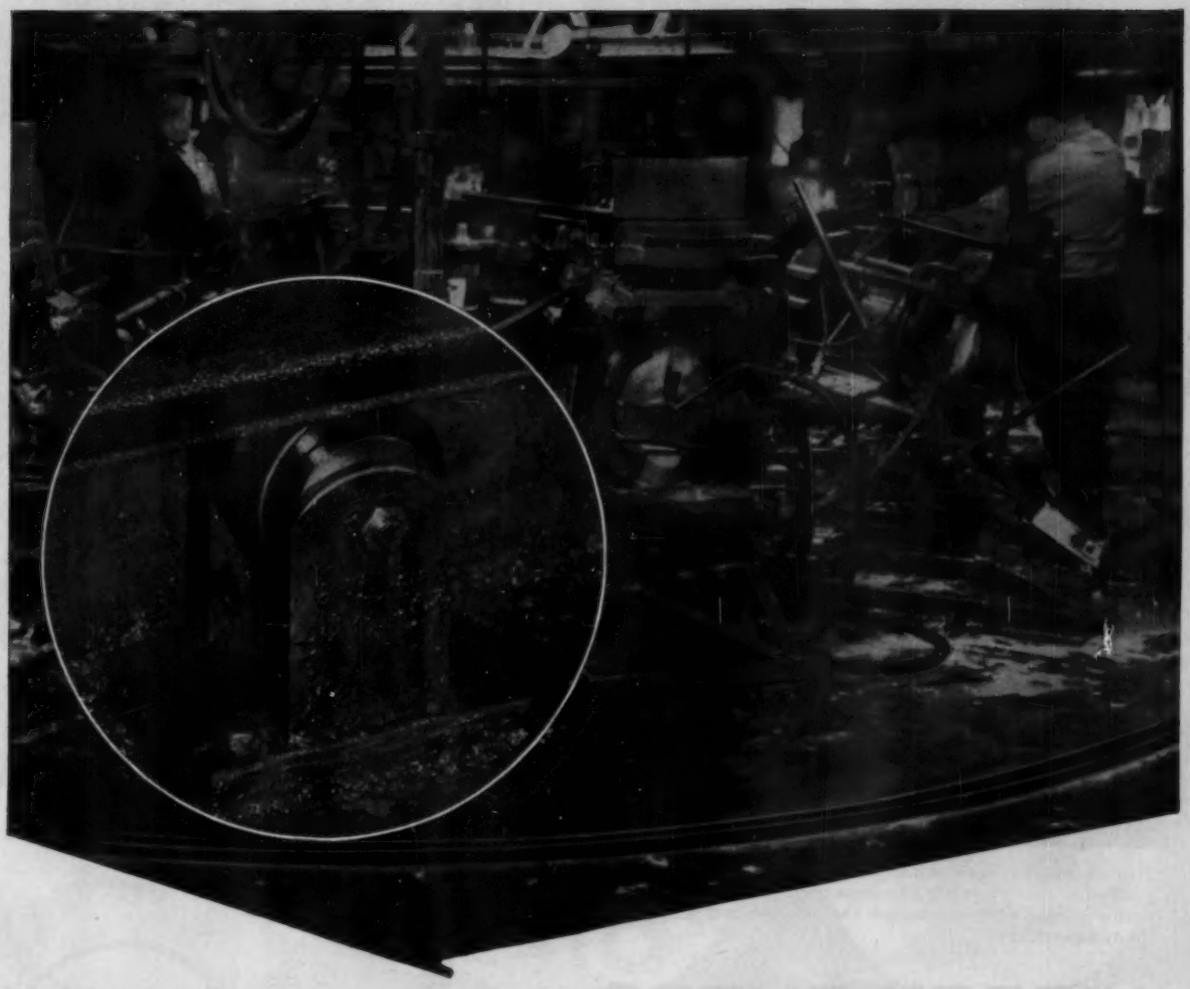
Portable Lift Magnet Operates From Self-Contained Battery

Because of its self-contained power supply, Magna Lift can be used anywhere, independent of the proximity of electrical power lines. With a 4000-lb plus lifting capacity, it is powered by a built-in standard replaceable dry-charge battery.

The magnet has a built-in charger, with a plug-in receptacle and control panel with on-off switch and charging indicator. Model LM4, described, is priced at $385 fob factory.

Hanchett Magna-Lock Corp, Magnetic Chuck & Devices, P O Box 816, Big Rapids, Mich

MORE DATA? Circle 100, inside back cover



Bearings, Inc. turned this turntable from a costly maintenance problem into a smooth, trouble-free operation!

Our customer, an aluminum foundry, designed and built this system for continuous and automatic pouring of permanent mold castings. The turntable is approximately 20 feet in diameter. Supporting the table, which weighs several tons, were 20 large, double-row bearings. The life of these bearings was only a few weeks and their cost, plus downtime, was becoming increasingly expensive.

Our bearing engineers were asked for a solution and, after an investigation, recommended a camroll bearing. Now, after many months of operation, all turntables in the plant are equipped with the bearings we recommended and there has not been a bearing failure in that period!

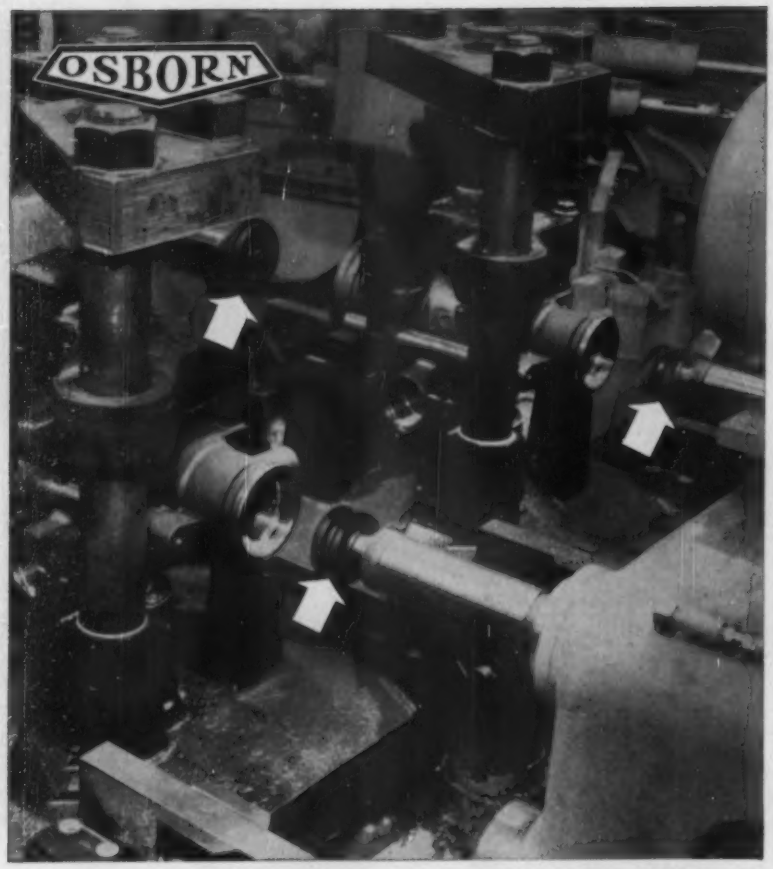
If you have a problem involving bearings, call the Bearings, Inc. branch nearest you for expert help. We are the authorized distributor for all the bearings we sell —your guarantee that the bearings we deliver will be of the latest manufacture and right for your application!

Providing bearing service in the North ➤ **BEARINGS, INC.**

OHIO: Akron • Canton • Cincinnati • Cleveland • Columbus • Dayton • Elyria • Hamilton • Lima • Lockland • Mansfield • Painesville • Toledo • Youngstown Zanesville • **INDIANA:** Ft. Wayne • Indianapolis • Muncie • Terre Haute • **PENNSYLVANIA:** Erie • Johnstown • Philadelphia • Pittsburgh • York **WEST VIRGINIA:** Charleston • Huntington • Parkersburg • Wheeling • **NEW JERSEY:** Camden • Newark **NEW YORK:** Balanrol Corp., Buffalo • Niagara Falls • **MARYLAND:** Baltimore • **DELAWARE:** Wilmington

and in the South ➤ **DIXIE BEARINGS, INC.**

FLORIDA: Jacksonville • **GEORGIA:** Atlanta • **KENTUCKY:** Louisville • **LOUISIANA:** Baton Rouge • New Orleans **N. CAROLINA:** Charlotte • Greensboro • **S. CAROLINA:** Greenville • **TENNESSEE:** Chattanooga • Kingsport • Knoxville • Nashville **VIRGINIA:** Norfolk • Richmond



In this automatic twin setup, Osborn TY® brushes are advanced into both ends of a pair of valve housings without surface contact. The drive head oscillates the brushes around the ring groove contours, then retracts . . . all automatically.

HIDDEN BURRS knocked off

In 5½ seconds with new OSBORN TY® Power Brushes

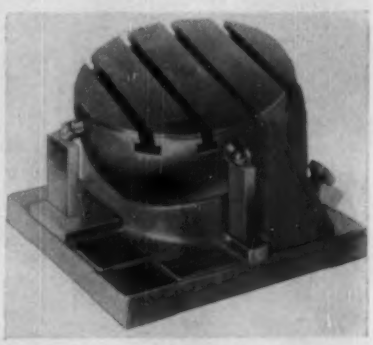
This large manufacturer of automotive power steering equipment uses Osborn TY® brushes to deburr double internal ring grooves in both ends of these valve housings. Former off-hand methods required lots of time . . . effort. Still, high quality standards were hard to obtain.

Today deburring is done automatically with Osborn TY brushes . . . in just 5½ seconds. *High quality results are uniform . . . consistent.* These tough, durable TY brushes operate 16 hours a day in a 96-station automatic transfer machine. Even in this rugged service, brush life runs 2½ to 3½ weeks.

An **O**sborn **B**rushing **A**nalysis—made in your plant now at no cost or obligation—is the first step toward improving your metal finishing operations of every description—deburring, cleaning, polishing, precision blending. Write or phone for details. *The Osborn Manufacturing Company, Dept. C-99, Cleveland 14, Ohio.* Phone ENdicott 1-1900.

Osborn Brushes

Metal Finishing Machines . . . and Finishing Methods
Power, Paint and Maintenance Brushes • Foundry Production Machinery



Compound Angle Sine Table Available in Five Diameters

Matrix high precision compound angle sine table, accurate to within 10 sec of arc, is available in 9 in. (illustrated), 13, 18, 26, and 36 in. diameters. A hemisphere riding in a conical seat replaces the conventional hinged bearings at 90° and permits any angle up to 45° to be set as a single cr as a compound angle. The table can be used also with autocollimator and angle gage blocks for optical settings of angles.

Engis Equipment Co, Division of Engineering and Scientific Instrumentation, 431 S Dearborn St, Chicago 5, Ill

MORE DATA? Circle 101, inside back cover

Gage Measures Plating, Coating Thickness of 0.0001-0.015 in.

Plategage is a portable instrument for measuring plating or coating thickness from 0.0001 to 0.015 in. It can be used on silver, copper, nickel, chromium, cadmium, zinc, brass, tin and other metals with iron or steel as the base material.

The instrument is transistorized and comes with a magnetic probe, and two thickness calibration standards. It can measure curved surfaces as low as 1/16 in. OD or ½ in. ID. Price is $345.

Dyna-Empire, Inc, 1075 Stewart Ave, Garden City, NY

MORE DATA? Circle 102, inside back cover

NEW!

NēBEL HEAVY DUTY LATHES

entirely new...
proven design...

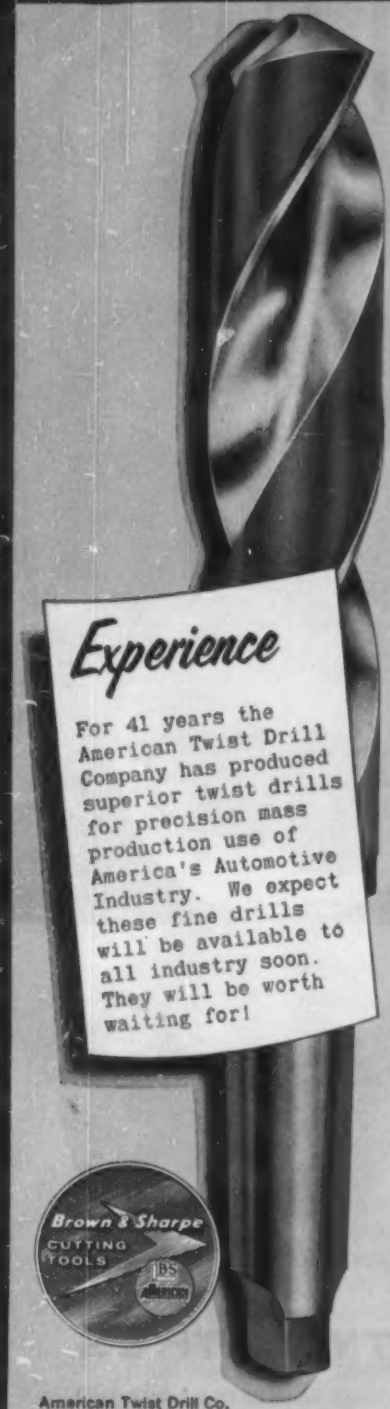
Here are just a few of the many proven design features that help extend Nebel economies even further in the heavy duty field. *Write for new, fully descriptive bulletins:*

- Heavy Duty Extension Bed Gap Lathe Model HXB 26/45 (Bulletin 211)
- Heavy Duty Model 2013 (Bulletin 212)
- Heavy Duty Model 2516 (Bulletin 213)
- Standard Duty Model 2516-20 (Bulletin 214)

NEBEL LATHE DIVISION • NEBEL MACHINE TOOL CORPORATION • 3407 CENTRAL PARKWAY • CINCINNATI 25, OHIO • *Lathe builders since 1809*

CIRCLE 276 READER SERVICE CARD

AMERICAN


Experience
For 41 years the American Twist Drill Company has produced superior twist drills for precision mass production use of America's Automotive Industry. We expect these fine drills will be available to all industry soon. They will be worth waiting for!
Brown & Sharpe
CUTTING TOOLS
AMERICAN

American Twist Drill Co.
Detroit, Michigan
Subsidiary of:
Cutting Tool Division
Brown & Sharpe Mfg. Co.,
Providence 1, Rhode Island

AMERICAN

NEW SHOP EQUIPMENT

Kwik-Chek Indicator Gives Electric Tolerance Signal

Electric indicator signals out of tolerance with an electric signal which is generated whenever established tolerance limits are exceeded. This signal can be used to turn on lights or for automatic control.

By addition of an adapter, the light box can be converted to a summarizing box for up to six electric indicators when gaging multiple dimensions. With this arrangement, an out of tolerance condition will be signaled by the over and/or under light. If all dimensions are within tolerance, the good light will signal.

Industrial Division, Hamilton Watch Co, Lancaster, Pa

MORE DATA? Circle 103, inside back cover

Line of Diamond Pins Available In Diameters From 0.020 to 0.250

Close tolerances at production rates can be achieved in hardened steel, ceramics, and even carbides since negligible wear is associated with the use of diamond. The grains are permanently bonded to the hardened tool steel shafts by Chrome-Lok process to assure maximum service life. Grains are uniformly distributed on the pin surface and cannot come loose; close dimensional accuracy can be maintained since they never need dressing. Breakage is eliminated since the diamond grit covers only the surface of the pin shaft. This shaft is undercut for a length of ⅜ in. to provide clearance for pins which are smaller than ⅛-in. shank. Two grit sizes are available: 200/240 and 80/100.

Titan Tool Supply Co, Box B, 1419 Hertel Ave, Buffalo 16, NY

MORE DATA? Circle 104, inside back cover

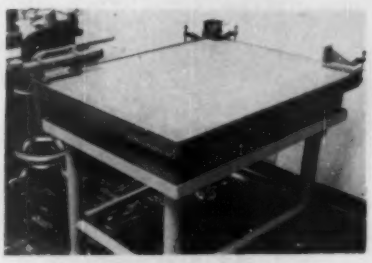
Machine Cleans and Deburrs 4-in. Copper Tubing

Toled-O-Matic No. 1 Buff-Ezy can process copper fittings and all size tubing up to 4 in. A 4-in. main brush with adjustable reverse L guide handels all external operations; for internal cleaning and deburring, three sizes of brushes and a rotary internal deburring tool work off the other end of the motor shaft under a clear plastic protective guard.

The 52-lb unit is fitted with a handle and is provided with a heavy metal baseplate for bench mounting. It is 10 in. wide, 10 in. high, and 17½ in. long. The 1/3-hp single phase motor operates on 115 v ac 60 c current. Price is $128.50.

Toledo Pipe Threading Machine Co, Toledo, Ohio

MORE DATA? Circle 105, inside back cover



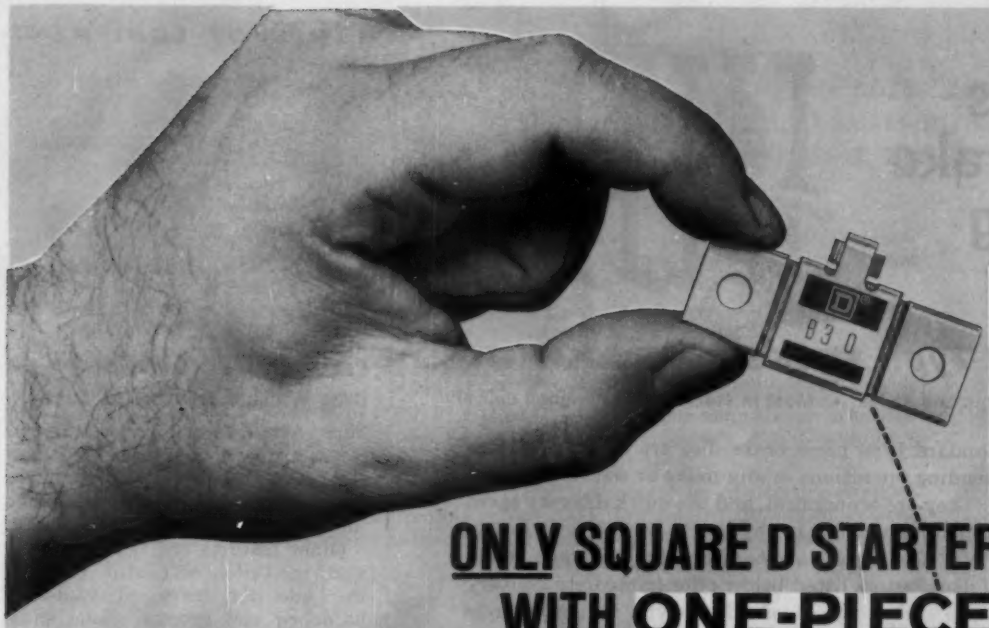
Granite Surface Plates Accurate to 10 Millionths

Surface plates made of Balfour pink granite containing 30% quartz have an over-all surface tolerance of 0.00001 in. High quartz content is said to assure long life and dimensional stability. Plate sizes range from 8 by 12 in. to 30 by 42 in. in no-ledge, two-ledge and four-ledge styles.

Herman Stone Co, 1860 N Gettysburg, Dayton 27, Ohio

MORE DATA? Circle 106, inside back cover

CIRCLE 277 READER SERVICE CARD



ONLY SQUARE D STARTERS WITH ONE-PIECE OVERLOAD RELAYS GIVE *Absolute* PROTECTION!

• Only Square D makes thermal overload relays with 1-piece construction—and only with 1-piece construction can you *know* you've installed the heater correctly. Square D 1-piece overload relays can be installed only one way. They are factory-assembled, individually tested and calibrated, completely tamper-proof. Repeated tripping will not affect accuracy.

You *pay* for overload protection—be sure you *get* it. Insist on Square D 1-piece overload relays for *absolute* protection.

Heat-responsive element (solder pot) provides accurate response to overload, yet prevents nuisance tripping.
Heat-producing element is an integral part of overload unit. It's permanently joined to solder pot, can't become misaligned.

D EXCLUSIVE— 1-piece Overload Relay for *ABSOLUTE* Protection!

Mail coupon today for simple "jig-saw" demonstrator —see why only Square D gives absolute protection

Square D Company
Department SA-237
4041 North Richards Street
Milwaukee 12, Wisconsin

Please send me information on Square D magnetic starters, along with your simple 3-minute "jig-saw" demonstrator

NAME_____

COMPANY_____

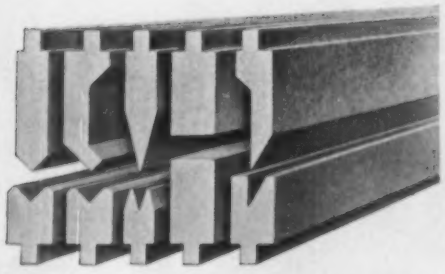
ADDRESS_____

CITY_____ ZONE____ STATE_____

SQUARE D COMPANY

wherever electricity is distributed and controlled

press brake tooling



Standard Type PRESS BRAKE DIES

62 different sizes and styles • Most in stock for off-the-shelf delivery

CHICAGO standard type press brake dies are used for a large variety of bending operations in any make or size of standard press brake. They are economical, and the quick delivery saves time in tooling up. Available in any length from 4 to 12 feet in increments of 2 feet; *induction hardened* or Diekrome steel.

The local distributors listed below offer immediate delivery on many sizes and styles of standard type CHICAGO press brake dies. If you have Bulletin STD-959 you can order any standard type die by number. Why not ask your nearest distributor for a copy? Also, if your requirements call for special multibend and forming dies, he can tell you about Dreis & Krump complete tooling service for any make of press brake.

Call your nearest distributor

ALABAMA
Birmingham
Hinkle Supply Co., Inc.
FAirfax 2-4541

CALIFORNIA
Los Angeles
Meyer Sheet Metal Mchry. Co.
MAdison 2-1477
San Francisco
Tay-Holbrook, Inc.
MArket 1-6800

GEORGIA
Atlanta
Allison Mchry. Co.
JAckson 4-1741

INDIANA
Indianapolis
E. L. Hunston Co., Inc.
WAlnut 5-9691

IOWA
Bonaparte
Corry's Machine & Tool—Phone: 112

KANSAS
Wichita
Ellfeldt Mchry. & Supply Co.
AMherst 7-9773

MASSACHUSETTS
Cambridge
Austin-Hastings Co., Inc.
Kirkland 7-4480

MICHIGAN
Detroit
J. Lee Hackett Co.—TRinity 2-6442

MINNESOTA
Duluth
Girard Steel Supply Co.
MArket 8-1001
Minneapolis
Minnesota Steel & Mchry. Co.
FEderal 3-6273
St. Paul
Girard Steel Supply Co.
Midway 6-8635

MISSOURI
Kansas City
Ellfeldt Mchry. & Supply. Co.
Victor 2-5494

NEW YORK
New York
Federal Machinery Corp.
CAnal 6-3022
H. Weiss & Co.
CAnal 6-4256

NORTH CAROLINA
Greensboro
Armentrout Mchry. Co.
Phone: 4-8218

OHIO
Cleveland
Wm. K. Stamets Co.
MAin 1-5124
Columbus
Vorys Brothers, Inc.
AXminster 4-4701

OKLAHOMA
Oklahoma City
Hart Industrial Supply Co.
REgent 9-2541
Tulsa
Hart Industrial Supply Co.
LUther 3-2175

OREGON
Portland
Hallidie Machinery Co., Inc.
ATlantic 2-2244

PENNSYLVANIA
Philadelphia
Delaware Valley Mchry., Inc.
OLdfield 9-4600
Milton Equipment Co.
WAlnut 2-1734
Pittsburgh
Wm. K. Stamets Co.
ATlantic 1-8091

TEXAS
Dallas
Briggs-Weaver Mchry. Co.
LAkeside 8-0311
Fort Worth
Briggs-Weaver Mchry. Co.
EDison 6-5621
Houston
Mehl Machinery, Inc.
FAirfax 3-1313

WASHINGTON
Seattle
Hallidie Machinery Co., Inc.
PArkway 3-9520

WISCONSIN
Milwaukee
Production Equipment, Inc.
GReenfield 6-6075

CANADA
A. R. Williams Mchry. Co., Ltd.

ALBERTA
Calgary—Phone: 5-4425
Edmonton—Phone: 24341

BRITISH COLUMBIA
Vancouver—TAtlow 9411
Victoria—Phone: 4-7623

MANITOBA
Winnipeg—SPruce 4-4458

NOVA SCOTIA
Halifax—Phone: 5-4389

ONTARIO
Hamilton—JAckson 9-5388
Ottawa—CEntral 6-3661
Toronto—RUssell 7-2494
Windsor—CLearwater 4-4762

QUEBEC
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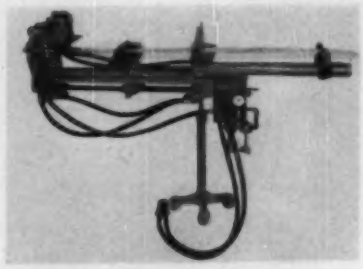
Hand and Power Bending Brakes
Special Metal-Forming Machines

CHICAGO DREIS & KRUMP

DREIS & KRUMP MANUFACTURING CO.
7434 S. Loomis Blvd., Chicago 36, Illinois



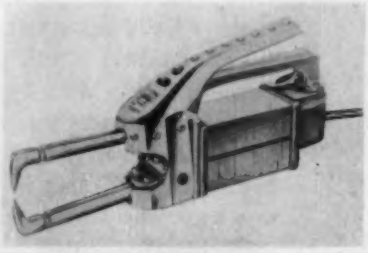
Power Press Feed Has Brake Drag Which Acts Only on Edge

Micro-Air 2 has new brake drag and stock guide which acts only on edges (¼-in. on each edge) and therefore permits polished metal to be fed to the die without marring the finish.

Other features are: all air operation; relocation of control panel to the side for increased visibility; hardened and ground leader pins; carbided grippers for wear and accuracy. Maximum capacity of feed is 36 in.

Nadel Tool & Mfg Co, Inc, 20 Warren St, New York 7, NY

MORE DATA? Circle 107, inside back cover



Portable Spot Welders, for Use On ⅛-in. Steel, Weigh 24 Lbs

Two models of a spot welder for use on mild steel, stainless steel, and galvanized iron up to ⅛ in. combined thickness are designed for operations on sheet metal or wire, and for use in metal fabricating plants, body and fender repair shops, farm or home workshops, building construction, and maintenance.

Of rugged construction, the completely portable units weigh 24 pounds. Model 11 operates from 115-v ac and requires 3.3 kva. Model 23 requires 230-v ac power and is rated at 4.4 kva. The design features a fixed top tong which permits one-hand operation on the unit, relieving the other to position the work. The top tong rests the weight of the unit on the exact spot to be welded, giving added contact pressure for a sound weld and reducing operator fatigue.

Metal & Thermit Corp, Rahway, NJ

MORE DATA? Circle 108, inside back cover

It's a breeze

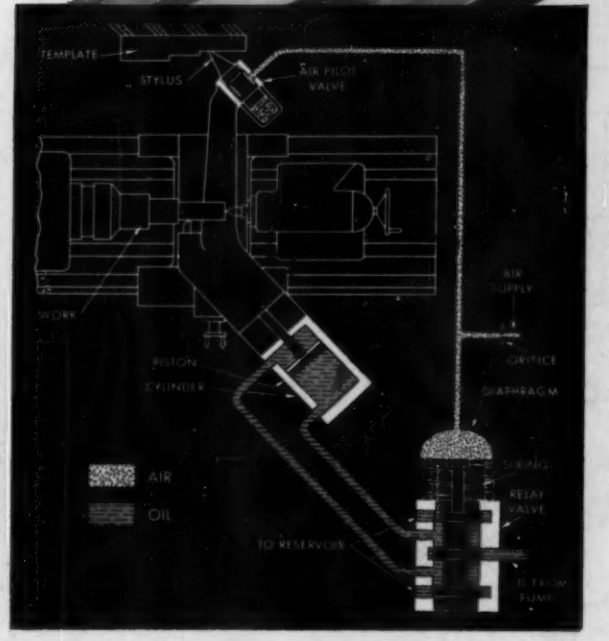
TO CUT COSTS, BOOST PRODUCTION AND QUALITY WITH THE MONARCH "AIR-GAGE TRACER"

No lathe development in recent years has equaled template controlled turning for substantial cost reduction. Its advantages, when performed the Monarch "Air-Gage Tracer" way, are many. This duplicating method:

- Always outproduces a manually operated machine; in some instances as much as 8 to 10 times.
- Provides automatic sizing, thereby reducing spoiled work to the absolute minimum.
- Imparts a smooth, stepless finish on any combination of cuts, whether turning, facing or boring.
- Often halves amount of stock left for grinding; sometimes eliminates grinding and polishing operations.
- On most work, reproduces accuracy of template within ± .001".
- Eliminates the need for expensive form tools and the cost of multiple tool setups.
- Allows a complete setup change in as little as 15 to 20 minutes; tool change in 1 minute.

Write for complete descriptive booklet No. 2608. It contains dozens of typical job examples... ***The Monarch Machine Tool Company, Sidney, Ohio.***

Above is a Monarch Series 62 Preselector Dyna-Shift Lathe with "Air-Gage Tracer" and auto cycle unit. This duplicating means may be factory applied to all Monarch lathes.



This diagrammatic drawing shows simplicity of "Air-Gage Tracer" operation. Note that design deals with both air and oil in constant motion. Result—super-accuracy piece after piece, job after job.

Exclusive Features of the "Air-Gage Tracer"

1. The only lathe duplicator which utilizes the combination of air-hydraulic control. That's the secret of its super-accuracy.
2. The air circuit is an open loop servo system which provides air-gaging and multiplies both force and motion.
3. It's the simplest and most trouble-free of all lathe duplicating methods. Tracer head maintenance is never a costly problem.
4. Stylus pressure against template is only 5 to 6 ounces, practically eliminating template wear.
5. Either a flat or a round template may be used. Never is it necessary to use a large, bulky round template so that it can be indexed periodically due to excessive wear from high stylus pressure.
6. Available both in a rigid and swiveling type, the latter of which may be used at any setting between 45° and 90°. Universal nature of swiveling type a "must" for top production on many complex facing and boring operations.
7. The only lathe duplicator offered optionally with full automatic cycling and potentiometer feed control.

Monarch
TURNING MACHINES
ACCURACY • ECONOMY • LONG LIFE
FOR A GOOD TURN FASTER . . . Turn to MONARCH

THESE 13 SPECIAL ALLOYS FROM *can help you solve design problems . . .*

As the result of the knowledge gained over the years by working closely with hundreds of customers in helping solve innumerable design and production problems, the Mueller Brass Co. has developed a series of special alloys for use in tough or unusual applications.

This group of special alloys, each having distinct characteristics and advantages, are available in rod form in many sizes and shapes as well as forgings.

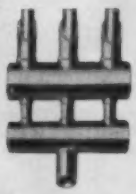
CHARACTERISTICS AND APPLICATIONS	ALLOY NO.	NAME	TEMPER
TUF-STUF® ALUMINUM BRONZES AND NICKEL ALUMINUM BRONZES have great strength characteristics. All are more resistant to corrosion cracking under load than copper-zinc alloys and, in addition, some are heat-treatable. They can withstand heavy pounding and have proved excellent for such parts as gibs, cams, valve seat inserts, shifting forks and propeller hub cones.	224E-30	"Tuf-Stuf" Aluminum Bronze	BRINELL 1000 KG load 165
	224E-75	"Tuf-Stuf" Aluminum Bronze	BRINELL 1000 KG load 175
	224C	"Tuf-Stuf" Aluminum Bronze	BRINELL 1000 KG load 185
	224H	"Tuf-Stuf" Aluminum Bronze	BRINELL 1000 KG load 200
	224K	"Tuf-Stuf" Nickel Aluminum Bronze	BRINELL 3000 KG load 250
ALUMINUM SILICON BRONZE is free turning; has high strength, is corrosion resistant and non-magnetic and resistant to corrosion cracking under load.	802	Aluminum Silicon Bronze	ROCKWELL-B 75
600 SERIES® FORGEABLE BEARING ALLOYS range from high strength to low loaded ductile. All are corrosion resistant, free cutting, can be used with hard or soft mating members and can be soldered. They are employed in a great variety of applications ranging from pump gears and valve stems to pinion shafts and transmission rings.	600	Forgeable Bearing Alloy	ROCKWELL-B 88
	601	Forgeable Bearing Alloy	ROCKWELL-B 87
	602	Leaded Forgeable Bearing Alloy	ROCKWELL-B 87
	604	High Leaded Forgeable Bearing Alloy	ROCKWELL-B 86
	605	Low Leaded Forgeable Bearing Alloy	ROCKWELL-B 80
MANGANESE BRONZE ALLOYS are exceptionally strong, tough, resistant to shock and corrosion. Good for screw machine products and forgings for aircraft parts.	241A	Manganese Bronze A	ROCKWELL-B 85
	721	Manganese Bronze High Tensile Grade B	BRINELL 1000 KG load 200
TELLURIUM COPPER has very high electrical and thermal conductivity combined with good corrosion resistance and machinability. Excellent for electronic components.	799	Tellurium Copper	ROCKWELL-B 45

NOTE: The values shown are average values normally obtained in production. Variations must be expected in practice. The values should be used as a general guide rather than the basis for specifications.

ONE DEPENDABLE SOURCE FOR

COLD-PREST® IMPACT EXTRUSIONS

SINTEEL® POWDERED METAL PARTS



FORMED COPPER TUBE

MUELLER BRASS CO.

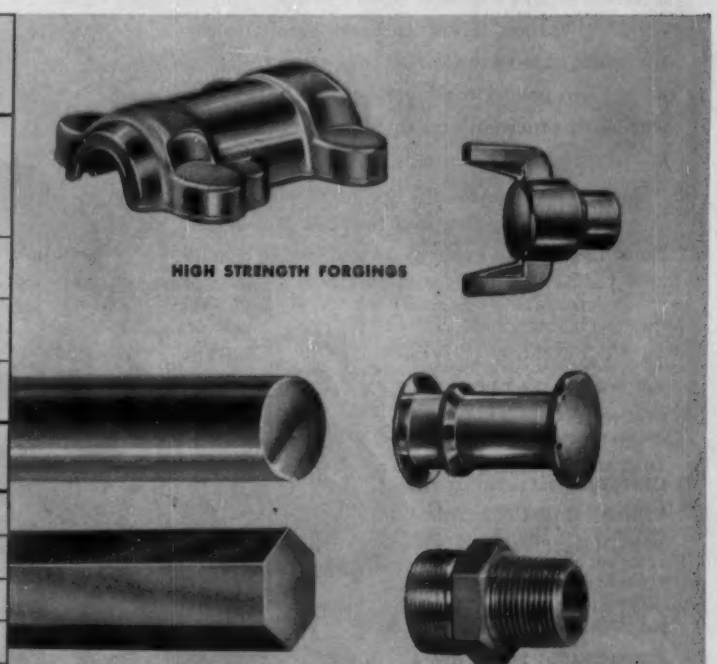
THE MUELLER BRASS CO.

lower costs and improve your products

Mueller Brass Co. engineers and metallurgists are always ready to assist in the selection of the proper alloy for your particular product.

Regardless of your responsibility... design, specification, production or purchasing... Mueller Brass Co. special alloys can help you lower costs and improve your products. Call the "Man From Mueller Brass Co." today and put these remarkable alloys to work on your toughest jobs.

Yield Strength at 0.5% Extension Lbs./Sq. In.	Tensile Strength Lbs./Sq. In.	Relative Machinability Free Cutting Brass=100%
50,000	82,000	30
65,000	100,000	30
62,000	95,000	35
70,000	90,000	30
65,000	105,000	20
35,000	85,000	60
60,000	90,000	25
55,000	78,000	35
65,000	85,000	65
55,000	75,000	80
45,000	70,000	55
55,000	78,000	25
68,000	115,000	35
40,000	43,000	90



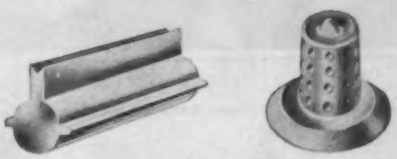
HIGH STRENGTH FORGINGS

ROD SHAPES FOR SCREW MACHINE PRODUCTS

For further information on these alloys write today for Special Alloys Kit No. 13. Engineering information on other fabricated products is also available... please specify the manual you desire.

ALL THESE QUALITY PRODUCTS

SAND CASTINGS



CUSTOM EXTRUDED PLASTIC SHAPES AND INJECTION MOLDINGS

MADE IN U.S.A. TO THE STANDARDS OF AMERICAN INDUSTRY

PORT HURON 24, MICHIGAN

301

ACCURACY
to keep machining economical

SOUTH BEND 14½" LATHES

Tolerances don't dictate slow-ups when you are using these precision lathes. Their accuracy, smoothness and operating ease save time as well as material on the tough jobs. With proper tooling, work can often be machined with such precision and smoothness that subsequent grinding, honing or lapping operations may be eliminated. Dollar-for-dollar you get more in South Bend Lathes. Write for catalog now and find out how South Bend Lathes can lower your machining costs.

SPECIFICATIONS

SWING: 14½" over bed and saddle wings.

DISTANCES BETWEEN CENTERS: 24" to 60".

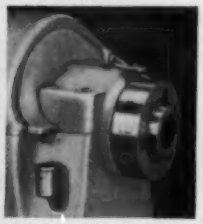
COLLET CAPACITY: 1 1/16".

SPINDLE SPEEDS: 6, 8, 12 or 16. 3-step cone pulley optional at no extra charge.

FEEDS: 48 each—longitudinal, cross and thread cutting.

BASE PRICE: $2074 f. o. b. factory.

OPTIONAL FEATURES



Cam Lock or Long Taper Key Drive Spindles to provide greater interchangeability of chucks, collets and fixtures.

Hardened—Ground Bed Ways to resist wear and scoring under severe conditions.

South Bend Lathe, South Bend 22, Indiana

Send literature on ☐ 14½" Lathes, ☐ 9" to 16-24" Lathes, ☐ Turret Lathes, ☐ Milling Machines, ☐ Shapers, ☐ Drill Presses, ☐ Pedestal Grinders.

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STREET.....

CITY..... STATE.....

SOUTH BEND LATHE

Up to 36 months to pay.

SOUTH BEND 22, INDIANA

Building Better Tools Since 1906

FIELD REPORT...

New SA Corp Formed by Willys And Thompson Ramo Wooldridge

New corporation, Productos Thompson Argentina (PTA) to manufacture valves and other automotive parts for the Argentine automotive industry has been formed by Thompson Ramo Wooldridge of Cleveland and Industrias Kaiser Argentina (IKA), an affiliate of Willys Motors. Initial capitalization of about $2 million was contributed in equal shares by the founding companies.

Construction of the new plant will begin immediately at Santa Isabel, just outside of the city of Cordoba where IKA operates Argentina's only fully integrated automotive plant. IKA manufactures Jeep vehicles including station wagons and trucks, and Kaiser Carabela, Bergantin, and Renault Dauphine passenger cars. Full capacity of the new plant will be reached eight months after start of operations. It's expected that 200 Argentine workers, technicians, and supervisors will be employed.

Ford to Buy Sherman Products

Sale of most of the assets of Sherman Products Inc of Royal Oak, Mich, to Ford Motor Co has been approved by Sherman directors who also approved dissolution of the company, subject to stockholder approval. Sherman produces power diggers, backhoes, and industrial loaders for use with the Ford and Fordson tractors, and two types of transmissions sold as options in Ford tractors. Ford's Tractor & Implement Division intends to continue to manufacture the lines of equipment.

Baldwin Units to Be Merged

Baldwin-Lima-Hamilton's Hamilton, Ohio, division and Loewy-Hydropress division are consolidating with the Eddystone division which is now called the Industrial Equipment Division. Step would cut down operating overhead but retain the approximate sales of the three former divisions. Move is expected to be completed within five or six months.

Automatic grinding wheel balancing is demonstrated by Cincinnati Milling Machine Co at the Mechanical Exhibit sponsored by the US Patent Office and held in the Main Lobby of the Commerce Building, Washington, DC. Here, Lincoln E Mehlhope (third from left), manager of the company's Patent Department, explains how vibration is eliminated through use of a patented wheel balancing mechanism applied to a Cincinnati precision grinding machine. Looking on are (left to right) Hayward A Gay, Cincinnati vice president; Robert C Watson, Commissioner of Patents; and Frederick H Mueller, Secretary of the Department of Commerce

Dow Establishes Lab For Magnesium Customers

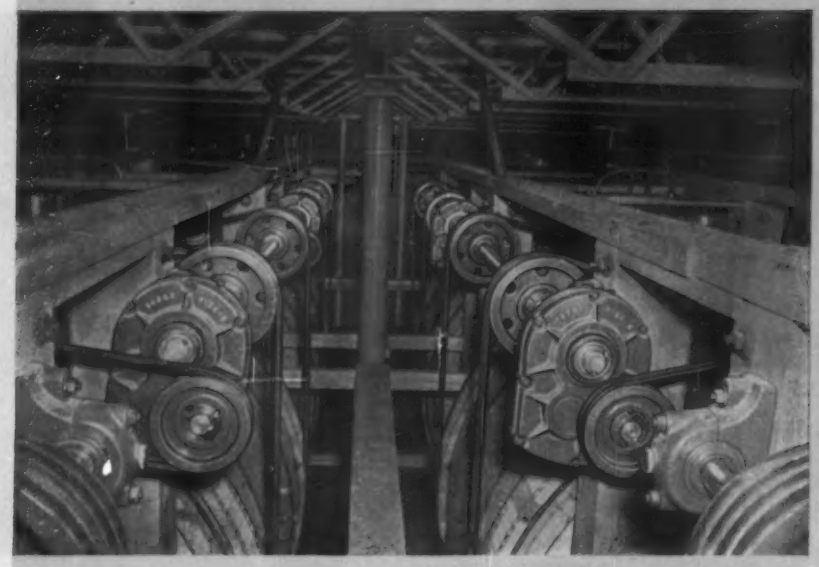
Dow Chemical Co, Midland, Mich, is setting up a customer-service laboratory designed to assist the automotive industry and other magnesium die casters. The $400,000 facility will be equipped to demonstrate the most modern techniques for melting and casting of magnesium and is expected to be in full operation by Nov 1. Customers will be able to obtain data on production rates, casting efficiency, and related factors in order to determine the basic economics in use of magnesium. Equipment will include 1500-ton and 500-ton diecasting machines and a low-pressure permanent-mold operation now under development. Melting and trimming facilities will also be available.

$80 Million Army Tank Orders

Chrysler Corp has a $60 million contract for 720 M-60 tanks and Bowen-McLaughlin-York Inc, York, Pa, will fill a $20 million order for 212 M-88 tank recovery vehicles. The M-60's will be assembled at Detroit Arsenal, Centerline, Mich; component machining work will be done at Chrysler's leased plant in Scranton, Pa. Chrysler has asked bids for subcontracting work from 1500 companies in 19 states and Canada. Ma-

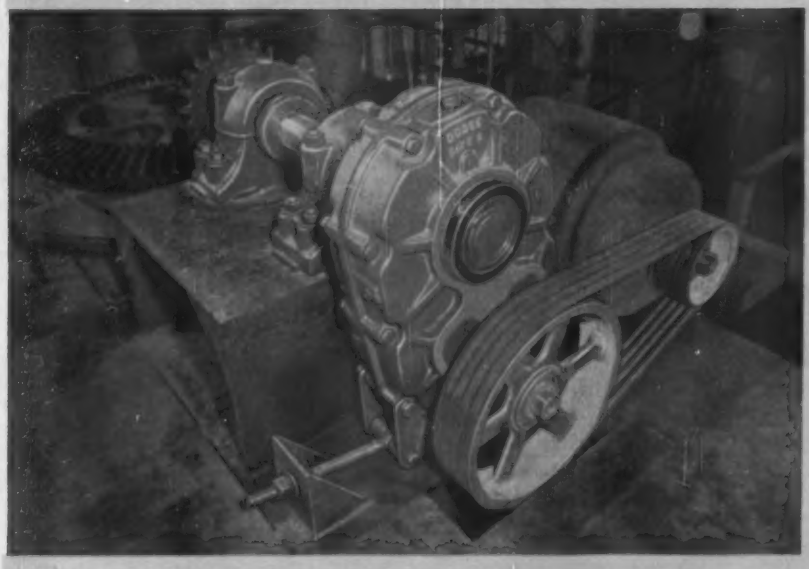
McGIRK'S WORKS by GEO. CRENSHAW

CERTAINLY GLAD YOU'VE JOINED THE PLANT, GIGGLY. I'M SURE YOU'LL FIND WE'RE JUST ONE BIG...
...'MORNING, SPRIGGS. MORNING, ROBBINS....
...HAPPY FAMILY AROUND HERE!
MOE'S CORNER
They forgot to unchain me!



DODGE TORQUE-ARM SHAFT MOUNTED SPEED REDUCER

Install it anywhere—with minimum time and effort. Here is an overhead installation on tanning drums. Torque-Arm reducers are resistant to acid fumes, salt water environment, moisture.



DODGE TORQUE-ARM SHAFT MOUNTED SPEED REDUCER

Can be positioned any place on the entire length of the shaft. It locks into place on *both* sides of the housing. Note modified torque arm on this installation on a mixer in a beverage plant.

The Speed Reducer Idea that

Two things account for the record popularity of Dodge Torque-Arm Speed Reducers. First, they cost less to install since they require no foundations, sliding motor rails or flexible couplings. Second—and most important—these modern reducers as developed by Dodge perform *brilliantly*. Tens of thousands of installations underscore Torque-Arm dependability. Torque-Arm is America's *quality* shaft mounted speed reducer!

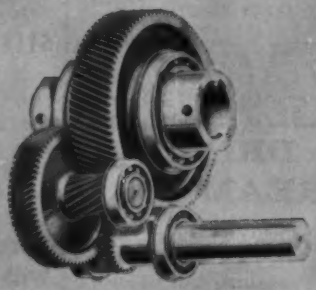
Torque-Arm has been so extensively adopted by industry that today models are available for a vast range of applications. The Torque-Arm line offers you capacities up to 170 hp—output speeds from 10 to 400 rpm—in single and double reduction series—with 5 to 1, 15 to 1 and 25 to 1 ratios. Models for vertical or inclined shaft operation are available—as well as special-application versions such as flange mounted, right

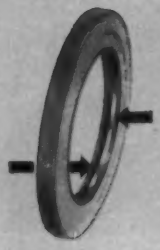
Rugged semisteel housing— a solid backbone for solid service

Here is a tough, corrosion-resistant housing with the strength to hold bearing seats in line for the life of the unit. Perfect shaft and gear alignment are assured by doweling the matched halves together and boring in line. No gear is overhung. Loads are carried easily, contributing to Torque-Arm's long life and high efficiency—97% in double reduction models, almost 99% in single!

AGMA rated gears— quality-guarded by continual tests

These helical gears have soft cores to withstand shock—and hardened surfaces to resist wear. Their quality is guarded in manufacture and assembly by the most modern methods of quality control, including inspection for runout, tooth spacing, helical lead and involute profile. They run quietly, mesh precisely. Teeth are crown shaved for maximum contact area. Gears are shrunk on their shafts to prevent shifting.





Modern double-lip seals keep oil in and dirt out

Modern synthetic, double-lip seals of the highest quality keep oil in and dirt out of the reducer case. These seals offer protection for the unit from dust and dirt and just as effectively insure cleanliness when operating in laundries, textile mills, food processing plants.

Re-ally Clicked!

angle and extended input shaft styles. Optional equipment includes a positive, sealed-in backstop and a positive overload release.

Ask your local Dodge Distributor. Or write us for our 64-page Torque-Arm Speed Reducer Bulletin, complete with engineering data and easy selection tables.

DODGE MANUFACTURING CORPORATION
100 Union Street • Mishawaka, Indiana

DODGE
of Mishawaka, Ind.

CALL THE TRANSMISSIONEER—your local Dodge Distributor. Factory trained by Dodge, he can give you valuable help on new, cost-saving methods. Look under "Dodge Transmissioneer" in the *white* pages of your telephone directory, or in the yellow pages under "Power Transmission Machinery."

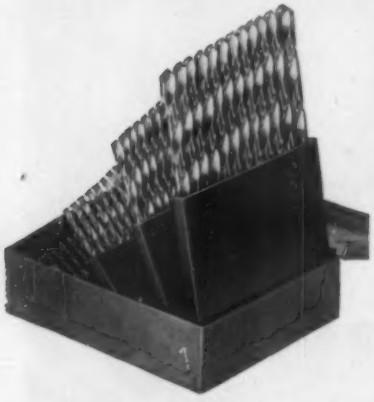
Hardened, Tempered and Ground-from-the-Solid!

It pays to specify

ACE

DRILLS
REAMERS
BLANKS

Premium Quality High Speed Steel, Solid Carbide and Carbide Tipped.



ACE DRILL SETS

Standard stock sets include Fractional, Wire and Letter size drills, packaged in convenient folding index cases.

ACE BLANK SETS

Uniformly hardened high speed steel reamer and drill blanks precision ground to new close tolerance limits available in standard Fractional, Wire and Letter series sets.

Call your local distributor today—or write Ace direct for latest catalog and price information.

ACE DRILL
Adrian, Michigan

ORIGINATORS OF "GROUND-FROM-THE-SOLID" DRILLS

CIRCLE 287 READER SERVICE CARD

Field Report . . .

jority of the companies are small business concerns, almost half of them in depressed areas. The M-88 vehicles will be assembled at York with subcontracts to 1185 companies in 11 states.

Studebaker-Packard Purchases Power Tool Concern

Negotiations have been completed for the acquisition of Gravely Tractors, Dunbar, W Va, manufacturer of self-propelled outdoor power tools for garden, farm, and commercial uses, by Studebaker-Packard Corp. Company, which will be operated as the Gravely Tractor Division, has manufacturing facilities in Dunbar; Albany, Ga; Fort Scott, Kans; and Torquay, England.

$118 Million Contract . . .

. . . has been signed by Air Force and Convair Division of General Dynamics Corp for continued production of Atlas ICBM's. New contract covers production for both weapon system and space booster uses.

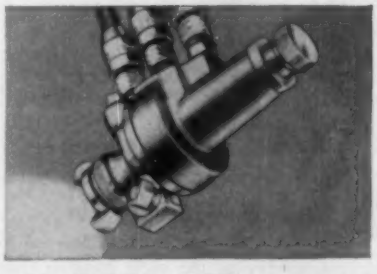
Ultrasonic Industries Ties In With Danish Equipment Firm

Agreements have been concluded between Ultrasonic Industries Inc, Albertson, LI, NY, and Industrikeme A/S, Denmark's leading metal finishing equipment manufacturer, for mutual distribution of each company's products in their respective countries. UI's mass-produced, low-cost diSONtegrator ultrasonic cleaners will be stocked and marketed in Denmark, and the Scandinavian-made machinery will be stocked and

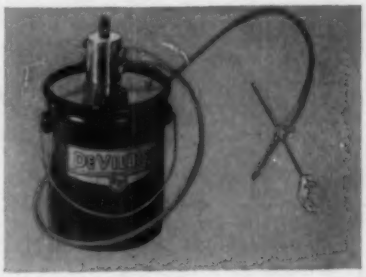
"That is the starting salary here, young man! . . . and stop referring to it as our 'get-acquainted' offer!"

Increase the life of forming and cutting tools with spray cooling

Another benefit of DeVilbiss total service



Use DeVilbiss WDB spray gun for heavy-duty, high-volume applications. Continuous or intermittent spray (up to 60 spray cycles/min). Manual or automatic control.



DeVilbiss Multi-Mister is designed for jobs requiring continuous or intermittent fine spray mist. Complete with one- or five-gallon tank, one to four spray nozzles.

• • •

Write for complete data to: The DeVilbiss Company, Toledo 1, Ohio.

FOR TOTAL SERVICE, CALL
DEVILBISS

CIRCLE 288 READER SERVICE CARD

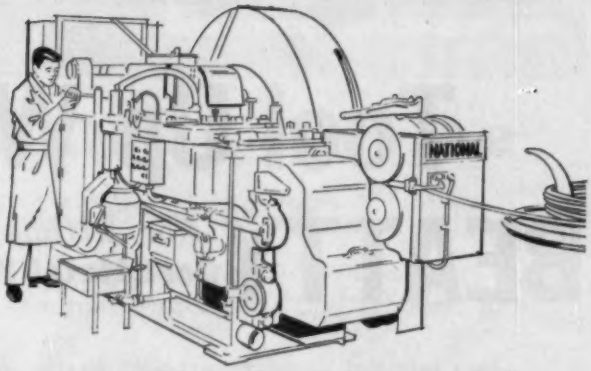
MADE FROM WIRE!

BOLTMAKERS make these interesting parts, and countless others, every day from wire.

Operations include cutting off, extruding, heading, trimming, pointing and thread-rolling.

It's just possible *your* metal parts can be made faster, stronger and at lower cost in Boltmakers (or in other types of Nationals).

May we help you investigate?



NATIONAL 1/2-INCH BOLTMAKER
4,200 PARTS PER HOUR!

Founded 1874—DESIGNERS and BUILDERS of MODERN FORGING MACHINES • MAXIPRESSES • REDUCEROLLS • COLD HEADERS BOLTMAKERS • NUT FORMERS • TAPPERS • NAILMAKERS CO-PIONEERS WITH INDUSTRY OF ADVANCED METALWORKING PRODUCTION METHODS

NATIONAL MACHINERY CO.

TIFFIN, OHIO, U. S. A.

HARTFORD DETROIT CHICAGO

DETAIL FLANGE PUNCH
Speeds single hole flange punching; eliminates end-for-end turning of beams. Punches 1½" hole through 1" mild steel. 100-ton capacity.

GAP TYPE PRESS
For forming, bending, flanging, pressing. 250-ton capacity.

GUILLOTINE BAR SHEAR
For production or short run shearing of rounds, squares, angles and bars without changing tools. 43 to 300 ton capacities.

GUILLOTINE BEAM PUNCH
For punching flanges and webs of I-beams from 6 to 30 inches. Large die space; clear working space. 200-ton capacity.

GUILLOTINE BEAM FLANGE PUNCH
Speeds flange punching of beams. Built-in adjustable tools save set-up time. Four punching units. 200-ton capacity.

Tool Up With BEATTY *For Efficient Low Cost Metal Working*

Savings in metal working start with Beatty machines . . . job-engineered equipment that is especially designed to speed work flow and provide dependable, accurate performance — on the production line or on short run jobs or repair work. Beatty machines are built rugged and rigid to give more low-cost, maintenance-free production per man-hour; earn more profits per square foot of floor space and dollar investment.

WRITE FOR FREE DESCRIPTIVE LITERATURE on some of the BEATTY LINE of metal working equipment: Shears, Punches, Presses, Spacing Tables, Bulldozers, Stamping Trimmers

BEATTY MACHINE & MFG. CO.
946 150th Street, Hammond, Indiana

Field Report . . .

serviced here. First product resulting from the association will be a two-stage, half-gallon capacity ultrasonic vapor degreaser made of Scandinavian stainless steel; the ultransonic portion will be made in the US and the balance will be fabricated in Denmark.

Bell Helicopters Due for Rise

Bell Helicopter may be in line for a big military order that should further stabilize the company's operations. Army announced on the West Coast that it hopes to have 2500 of Bell's turbine powered HU-1 series in operation by 1970. Company management in Dallas, however, says that production contract figures on the HU-1 covering the next two and a half years are the same as present rates and that employment is expected to remain at about the present level of 3200. One reason for Bell's playing down workload optimism: labor contract negotiations are currently in progress.

Two Metal Firms to Consolidate

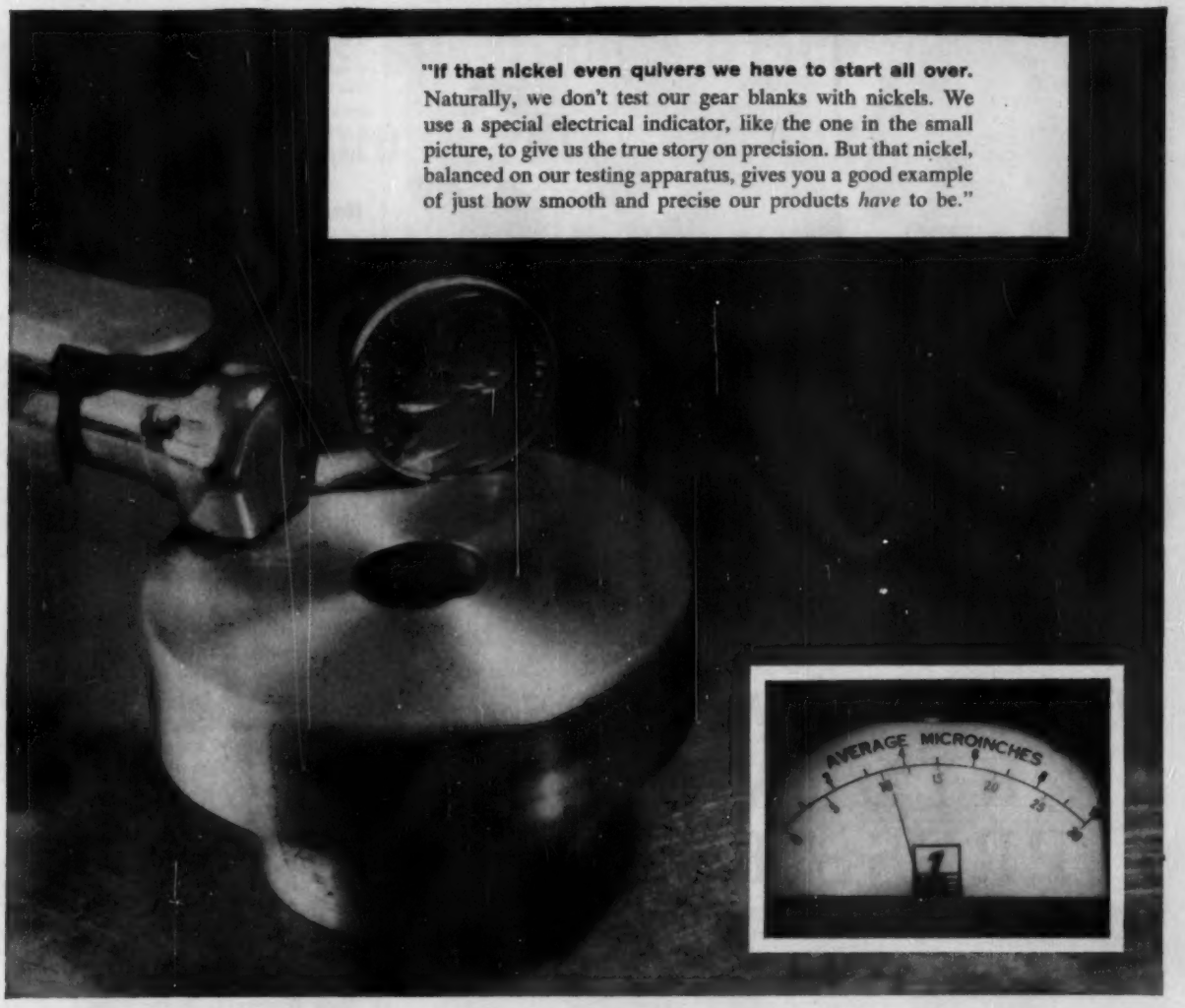
Negotiations are in process for the purchase of Herrick Co of Boston by W E Clark & Co of Everett, Mass. Established in 1893, Clark specializes in hot rolled carbon steel products comprising bars, sheet and strip, as well as flame cut plates. Herrick Co, founded in 1877, produces sheet metal products including galvanized sheet steel, copper, aluminum, zinc, and stainless.

LA Plant to Build Valiants

The Los Angeles Chrysler plant will be converted to Valiant car production starting with the 1961 models. Production of Chrysters, which had previously been assembled in Los Angeles, is now confined to the Jefferson plant in Detroit.

Maremont Buys Into Saco-Lowell

Maremont Automotive Products has acquired 127,500 shares (23%) of Saco-Lowell Shops common stock through open market purchases in recent months. It's reported that no merger of the two companies is being contemplated at the present time. Maremont, an 83-year-old Chicago company, is a leading manufacturer of automobile replacement parts. Saco-Lowell, headquartered in Boston, recently completed relocation of its entire manufacturing facilities for heavy textile equipment from


"If that nickel even quivers we have to start all over. Naturally, we don't test our gear blanks with nickels. We use a special electrical indicator, like the one in the small picture, to give us the true story on precision. But that nickel, balanced on our testing apparatus, gives you a good example of just how smooth and precise our products *have* to be."
AVERAGE MICROINCHES
10
15
20
25

"We depend on Cities Service for absolute precision!"

Lester E. Hoffmann, Treasurer and Vice-President
American Screw Machine Products Co., Chicago, Ill.

"The screw machine business is a highly competitive trade. We've built our business and our reputation on top quality, high-precision products . . . gear blanks that require the closest tolerances in *all* aspects. That means *we have to have* the best-quality cutting oil available. We've depended on Cities Service for nearly 25 years and they've never let us down."

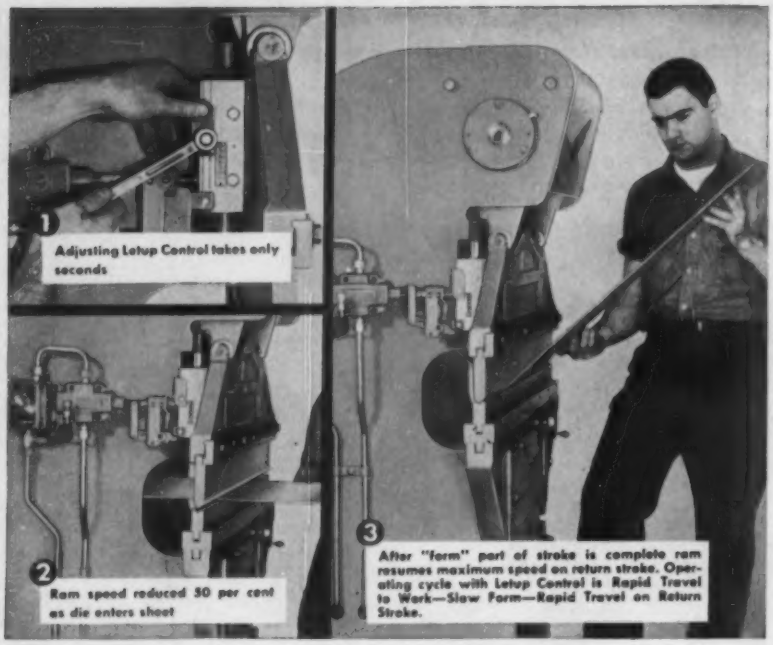
"Matter of fact," says Mr. Hoffmann, "they insisted we try other brands just to prove that Cities Service was the best for us. They proved their point. We've stuck with Cities Service."

At the present time, American Screw Machine Products Co. is using Cities Service CHILLO 10 Cutting oil, and some CHILLO 22. As Mr. Hoffmann says, "The sulphur and chlorine additives prevent welding and galling action which allows for fine finishes and long tool life that maintains high-precision, top-quality work."

If you use petroleum products in your operations, why not talk with your Cities Service Lubrication Engineer? He can help you get the most from your operations by giving you the finest products, the best service available. Or if you prefer, write: Cities Service Oil Company, Sixty Wall Tower, New York 5, N. Y.

CITIES SERVICE

QUALITY PETROLEUM PRODUCTS


1
Adjusting Letup Control takes only seconds
2
Ram speed reduced 50 per cent as die enters sheet
3
After "form" part of stroke is complete ram resumes maximum speed on return stroke. Operating cycle with Letup Control is Rapid Travel to Work—Slow Form—Rapid Travel on Return Stroke.

Letup Control on New High Speed

HYDRAULIC PRESS BRAKE

★ *Eliminates whipping of material when forming*
★ *Makes for fast, safe forming of large sheets*

DI-ACRO HYDRA-POWER PRESS BRAKE

An adjustable flow control valve is the basic element in the Letup Control, an accessory for all Di-Acro Hydra-Power Press Brakes.

Models with 3′, 4′ and 6′ bed and ram have Stroke Adjustment, speed from 32-80 strokes per minute, capacities of 16, 18 and 20 gauge mild steel. These and other *features exclusive to hydraulic press brakes* spell out *Efficient, Safe* operation for a rapidly growing list of satisfied customers.

Heard about the new Di-Acro Rol-Form Dies? They eliminate work marking, reduce the number of set ups and cut changeover time. Also a complete line of standard Di-Acro Press Brake Dies are available.

Find Us Fast in the Yellow Pages

Consult the yellow pages of your telephone directory under machinery, machine tools for the name of your Di-Acro distributor or write us for Quick Facts Folder describing this and other Di-Acro Machines.

di-acro PRECISION METALWORKING MACHINES

pronounced die-ack-ro

O'NEIL-IRWIN MFG.CO.

405 8th Avenue • Lake City, Minnesota

Field Report . . .

New England to the South. The 147-year-old firm also supplies some parts to the automotive and agricultural implement industries.

Nash Co Buys Peerless Machine

J M Nash Co of Milwaukee and Oshkosh, Wis, has acquired the Peerless Machine Co, Racine, Wis, manufacturer of metal sawing machines. Company will operate as a wholly owned subsidiary of Nash which also owns the Bell Machine Co and Dyken Manufacturing Co of Oshkosh and the Canvas Products Corp of Fond du Lac. Peerless, founded in 1916, built and sold the first power driven, high speed wet cutting machine on the market.

$2.6 Million Contract to Ford Div

Ford Motor Co's Aeronutronic Division, Newport Beach, Calif, has a contract from the Air Force Ballistic Missiles Center to act as system engineer and payload and test contractor on a high altitude rocket-space program known as Hyper-Environmental Test System 609A. It'll provide the Air Force with an off-the-shelf capability of boosting various payloads to high velocity and altitude and will be used to test ballistic missile and space vehicle equipment and techniques and collect scientific data at space equivalent altitudes.

New Orders to Mare Island

Mare Island Naval Shipyard has two new ship overhaul contracts that'll take from 16 to 18 months to complete. The destroyer Agerholm has arrived for a $6 million overhaul and will be joined by the destroyer Swenson in June, due for a $3.5 million job. Both ships were as-

(continued on p209)

"Ah-ah-ah—Don't touch that dial . . ."

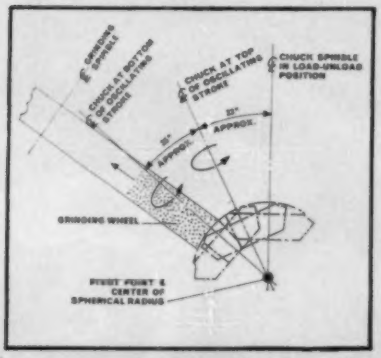
Grinds spherical surface of bevel pinions automatically at 260 per hour

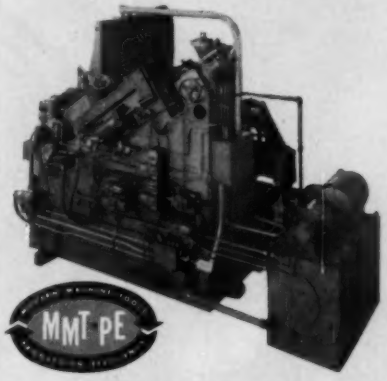
MATTISON HIGH-POWERED PRECISION

GRINDING METHODS

Here's peak pinion production with precision—and it's all automatic!

This special Mattison spherical surface grinder removes .008″ to .015″ stock from the back faces of SAE 1022 differential pinions at the net rate of 260 per hour—holds a form tolerance of .002″ on the radius.





Spherical seats are generated as the pinion simultaneously revolves on the work spindle and oscillates about the center point of the desired radius (Fig. 1). An 80 grit, 24″ dia. wheel cuts at 6500 sfm, with work rotating at 210 rpm and oscillating past the wheel. Eight passes finish a pinion.

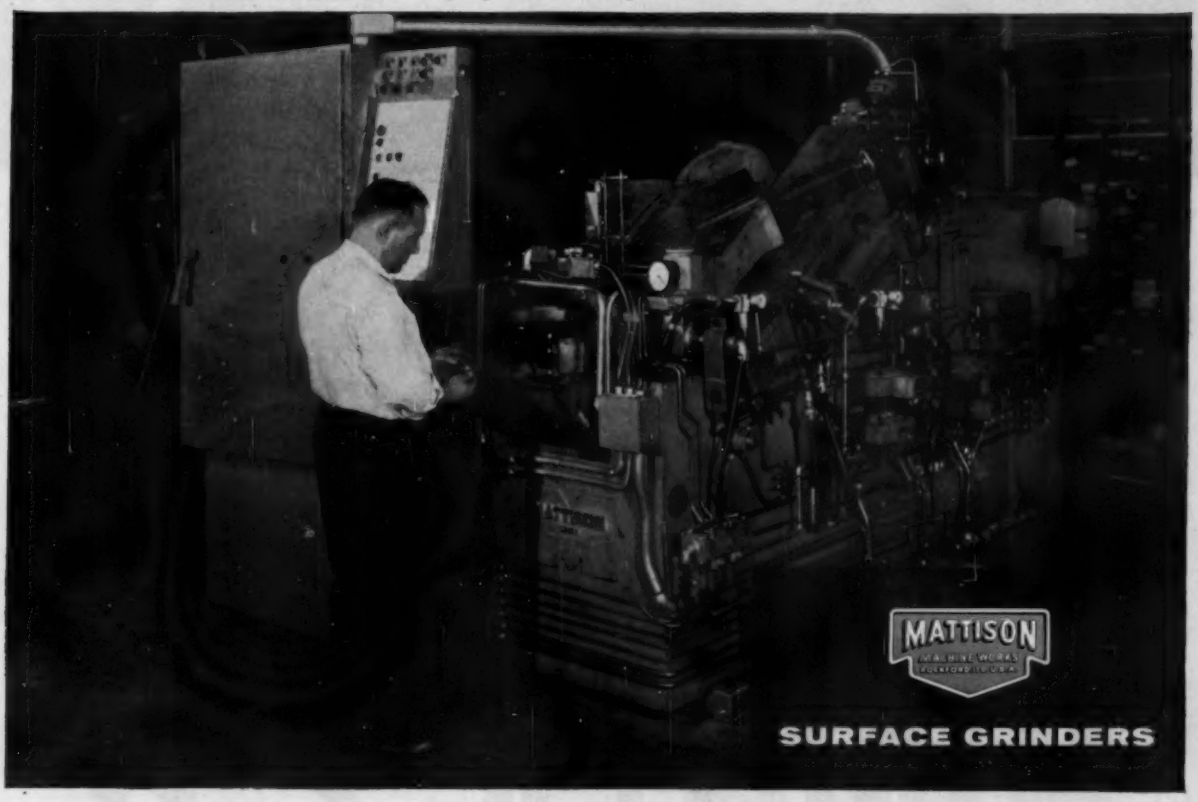
Automatic wheel dressing and wear compensations speed production

The wheel is self-dressing after initial concave forming by a simple swing-type diamond dresser mounted on the wheel slide. Wheel-wear compensation is controlled automatically by an air gage, which actuates the feed mechanism in .0002″ increments.

As the wheel slide feeds to the end of its plunge stroke, a limit switch actuates a time-delay relay, allowing the wheel to dwell and true the work surface. A three-second sparkout dwell completes the cycle.

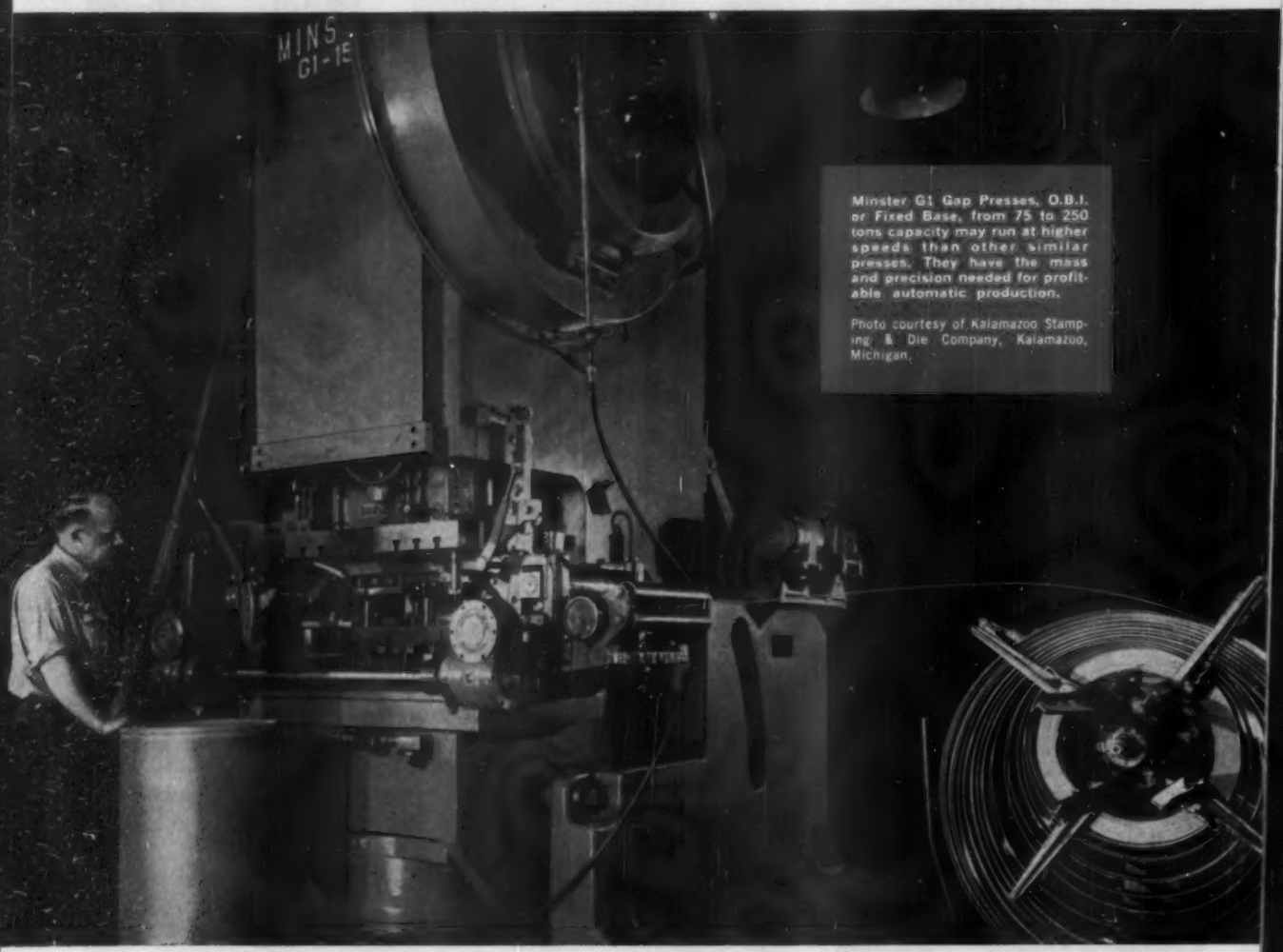
Here's automatic grinding in command of peak production! For details on how special grinders can increase production of *your* key parts, contact your Mattison representative or send prints and production requirements to:

MATTISON MACHINE WORKS
Rockford, Illinois Phone WOodland 2-5521



Eliminate expensive secondary press operations with

AUTOMATIC PRODUCTION



Minster G1 Gap Presses, O.B.I. or Fixed Base, from 75 to 250 tons capacity may run at higher speeds than other similar presses. They have the mass and precision needed for profitable automatic production.

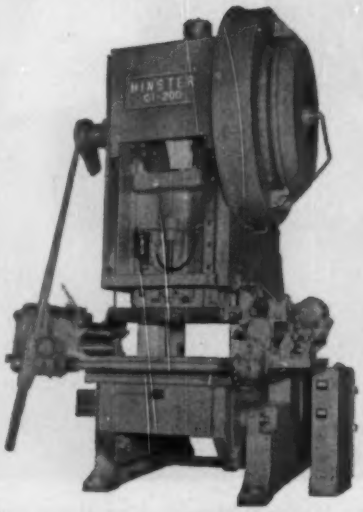
Photo courtesy of Kalamazoo Stamping & Die Company, Kalamazoo, Michigan.

Minster Heavy Capacity Gap Presses with Feeds

Progressive or compound die stamping jobs . . . long or short runs . . . are much more profitable when run automatically on the right Minster press with job-matched feed equipment.

Why pay for unnecessary rehandling of parts and storage space? Why tie up several presses when the job can be done faster and more accurately on just one press?

Minster offers a full range of presses and feeds plus technical knowledge and assistance to help you take full advantage of automatic production. Take a close look at your unit costs, then write or call . . .



The Minster Machine Company • Minster, Ohio

MINSTER®

CIRCLE 294 READER SERVICE CARD

Field Report . . .

signed to Mare Island under FRAM (Fleet Rehabilitation and Modernization) program devised by Navy to get maximum use from current ships in the fleet. Current workload picture is bright, according to Rear Admiral L V Honsinger, USN shipyard commander who also says that Mare Island stands a good chance of getting another Polaris sub contract if funds are made available.

Tennessee Products Lay-Off

Nashville, Tenn, headquarters of Tennessee Products & Chemical Corp reports that declining output of steel and requirements for alloying metals has resulted in a lay-off of 260 workers at its Rockwood and Chattanooga plants. Company spokesman describes the move as "an effort to adjust operations to steadily declining activity in the steel industry."

Keller Machine's Eighth Expansion

J & A Keller Machine Co, Buffalo designer and manufacturer of automation equipment, is constructing a 3000 sq-ft addition to its engineering offices, its eighth building expansion in the last ten years. Company, which employs 125 workers, is operating its plant on a two-shift, six-day-a-week basis.

Boesch Acquired by Waltham

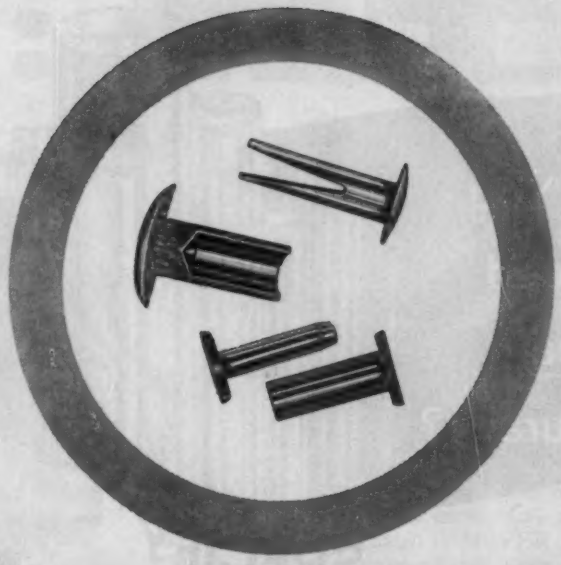
Waltham Precision Instrument Co, Waltham, Mass, has completed arrangements to purchase Boesch Manufacturing Co, Danbury, Conn, designer and manufacturer of toroidal coil winding machines, controls, and accessories. Acquisition is Waltham's second this year; it took over Electro-Mec Laboratory Inc, Long Island City, NY, producer of precision potentiometers, in February.

Texas Aluminum Co . . .

. . . has opened a $1 million 60,000 sq-ft facility in Mojave, Calif. Firm produces molded and extruded aluminum for the building and defense industries.

Chemetron Buys Scottish Firm

Chemetron Corp, Chicago, has completed arrangements to acquire Clyde Tube Forgings Ltd, Glasgow, a leading British manufacturer of welding fittings for industrial piping and pipeline transportation systems. The Tube Turns Division of Chemetron in Louisville will coordinate Clyde Tube Forgings' operations with its



COST-CUTTING PRODUCTION TEAM!

. . . the two-way answer to assembly problems

Here's a combination that cuts production costs and gets rid of assembly problems in a hurry—Milford Tubular Rivets made to high quality standards to assure a better finished product for you... Milford automatic rivet-setting machines that can be quickly adapted to your particular fastening needs.

Milford's MANUAL OF MODERN RIVETING PRACTICE may have the answers to your riveting problems. Ask a Milford Representative to show you how to use this manual to cut production costs.

THE MILFORD RIVET & MACHINE CO.

MILFORD, CONNECTICUT • NORWALK, CALIFORNIA
ELYRIA, OHIO • AURORA, ILLINOIS • HATBORO, PA

SPECIFY

WYCKOFF

Drawn and Ground . . . Turned and Ground
Turned and Polished

SHAFTING

Our diversified grinding and turning facilities assure:

- Finest Finish
- Exact Tolerances
- Unmatched Straightness

Available in a complete range of carbon and alloy steels to meet your specific requirements.

OUR CONSTANT RESEARCH PROGRAM IS YOUR BEST GUARANTEE OF QUALITY CONTROL

SPECIALISTS IN COLD FINISHED STEELS THROUGHOUT

WYCKOFF STEEL COMPANY

GENERAL OFFICES:
Gateway Center, Pittsburgh 30, Pa.

Branch Offices in Principal Cities
Works: Ambridge, Pa., Chicago, Ill., Newark, N. J., Putnam, Conn.

WYCKOFF STEEL PRODUCTS • Carbon, Alloy and Leaded Steels • Turned and Polished Shafting • Turned and Ground Shafting • Large Squares • Wide Flats up to 12¾" x 2¼" and 14" x 1¼" • All types of Furnace Treated Steels including Carbon Corrected Steels

Field Report . . .

own. Clyde's basic line of welding fittings will be supplemented with Tube Turns' wider range of products. Company's US plants produce fittings and flanges for piping as large as 42 in. in diameter in carbon steel and all other metals and alloys used for petroleum, chemical, and other industrial piping and pipelines. W C Conner Jr, head of Tube Turns' international sales, will serve initially as managing director of Clyde's Glasgow plant and sales organization.

New Tenn Firms

Two metalworking concerns plan to open plants at Murfreesboro. Perfect Equipment Corp of Kokomo, Ind, manufacturer of wheel balancing weights, will put up a 15,000 sq-ft facility, and Park Industries of Springfield, Ill, will soon begin production of steel lighters, cigarette cases, and tape measures in a 10,000 sq-ft building.

Western Electric Co. . . .

. . . will build a 125,000 sq-ft addition to its Nashville distribution center. Construction will begin this fall at a cost of $1.8 million. Expansion is expected to boost employment by 600.

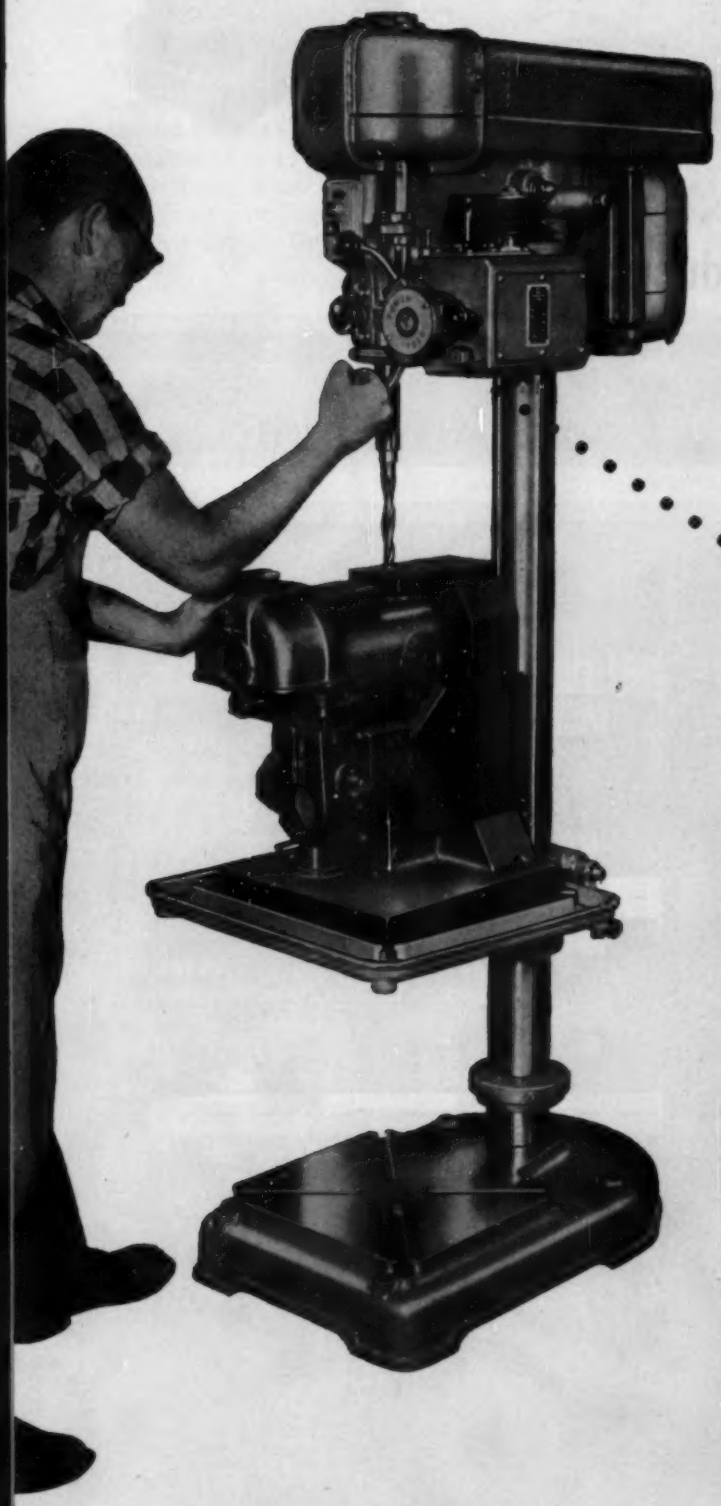
Servomechanisms (Canada) Ltd . . .

. . . Toronto subsidiary of Servomechanisms Inc, Los Angeles, has been purchased by Litton Industries of California. Candian company develops and manufactures electronic equipment mainly for airborne electronic and electro-mechanical instrumentation. Expansion of operations is planned with special

"Do I know the boss is coming? No. How does it go?"

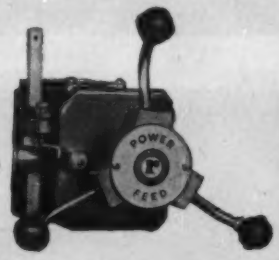
NEW: W-T WALKER-TURNER

20" 'POWER FEED' DRILL PRESSES



combine up-front control with one-hand operation

Every model in this new W-T "Light-Heavyweight" line (and there are 16 of them to fit your needs) offers a revolutionary new mechanical power feed with performance features NEVER BEFORE AVAILABLE on a standard drill press. Now you can do continuous, heavy duty production drilling faster, easier and with greater accuracy.



For unequalled flexibility—front mounted pilot wheel is mechanically integrated with clutch control to provide easy one-hand engagement of power feed; drill point pressure is infinitely adjustable from 0 to maximum capacity of machine; furnishes power and thrust for drilling 1" diameter holes, yet adjusts for use with 1/16" bits.

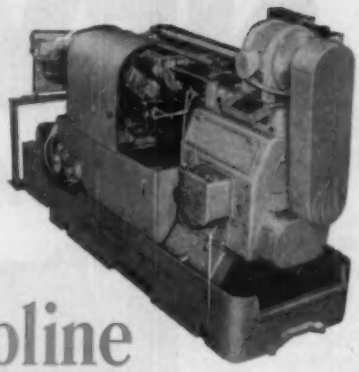
For unmatched versatility—built-in control permits remote operation and can be electrically, hydraulically or mechanically interlocked with other units or synchronized with automation devices. Operator can utilize four feed ratios, drill manually, mechanically or in combination.

See your Walker-Turner Distributor (under "TOOLS" or "MACHINE TOOLS" in the Yellow Pages) for a demonstration. The only way to really appreciate the many outstanding features of these new W-T 20" 'Power Feed' Drill Presses is to see them *in action.* For FREE brochure giving specifications and information on how to adapt your present W-T 20" drill presses to 'Power Feed', write: Rockwell Manufacturing Company, Walker-Turner Division, Dept. WF21 400 N. Lexington Ave., Pittsburgh 8, Pa. In Canada: Rockwell Manufacturing Company of Canada, Ltd., Guelph, Ontario.

WALKER-TURNER
"LIGHT-HEAVYWEIGHT" MACHINE TOOLS
another fine product by
ROCKWELL

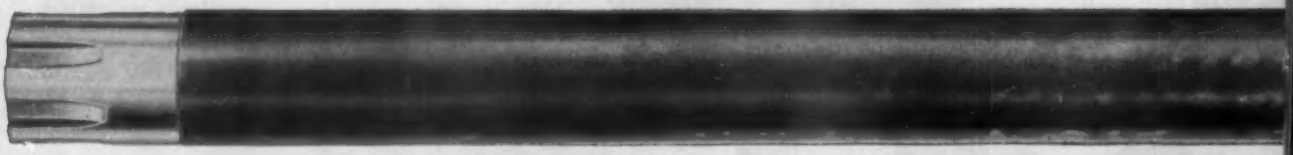
CIRCLE 297 READER SERVICE CARD

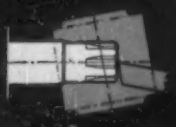
CIRCLE 298 READER SERVICE CARD ►



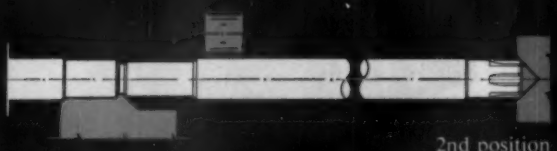
Acme-Gridley performs spline hobbing in a single set-up . . .

slashes ringer roll shaft production time 63%!

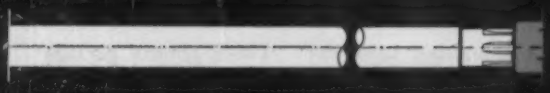




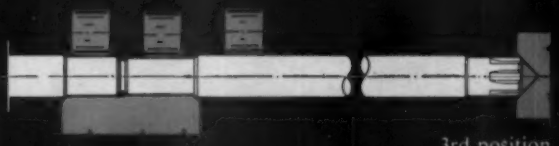
5th position
Hob Spline—Face Front (spindle clutch disengaged, spindle driven from hobbing attachment)



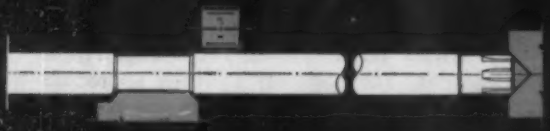
2nd position
Form Spline Dia. of Next Piece and Breakdown for Cut-off—Support



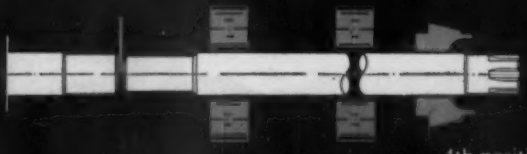
6th position
Feed Stock



3rd position
Shave Rear Dia. and Spline Dia.—Support



1st position
Form Rear Dia. Past Cut-off—Support



4th position
Support—Pick-up—Cut-off

6 Operations in 27.9 Seconds

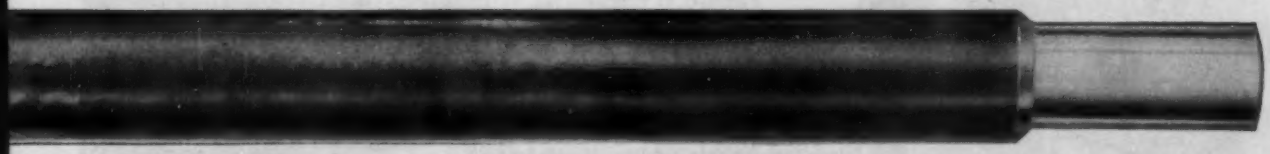
Here's how imaginative National Acme solutions to tough machining problems extend total machine capability and pay off in *tangible* production savings.

Spline hobbing is generally considered beyond automatic bar machine capability. Yet, an ingenious National Acme hobbing attachment . . . installed on an Acme-Gridley 1¼" RA-6 with modifications . . . lets a well-known manufacturer of ringer roll shafts do spline hobbing in the primary set-up; has cut per-piece production time 63%. In addition, a unique automatic feeding arrangement has drastically reduced stock-loading downtime.

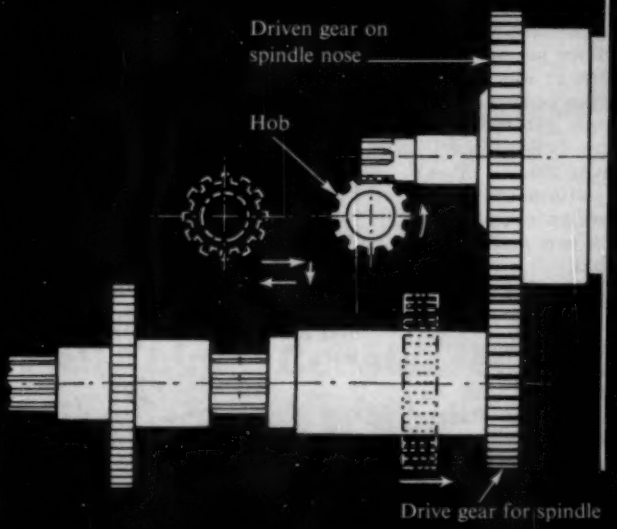
Special attachments like the spline hobber, plus such standard features as direct camming, independently operated toolslides, and a wide open tooling zone are the reason Acme-Gridley capability is limited by imagination only. No wonder cost-conscious manufacturers everywhere depend on Acme-Gridleys for higher mass production efficiency at lower cost. Detailed information on the world's most complete line of multiple and single-spindle automatic bar and chucking machines is yours for the asking. Call, write or wire.

National Acme's "Zone of Responsibility" includes all phases of cost reduction. Check YOURS . . . Then Check National Acme

Direct Costs: these include direct dollar savings as realized by thousands of manufacturers . . . an "everyday" job for Acme-Gridleys. **Indirect Costs:** effecting important savings in maintenance, downtime, scrap reduction, tool costs, etc. **Product Redesign:** teaming with your design group to take full advantage of Acme-Gridley's cost reducing capabilities. **Direct Material Costs:** our engineers provide important savings in this area by constantly matching machines and tools to modern metallurgical problems. **Make-or-Buy Reviews:** in many cases our Contract Division can assume your production headaches and relieve you of immediate capital investment. **Spot Modernization:** pioneering in modern tooling methods, and the flexibility of Acme-Gridleys can provide many "on-the-spot" savings.



Spline hobbing in the fifth position . . . a closer look



When the hobbing attachment advances, a gear on the attachment engages a gear on the spindle nose and drives the spindle at the required speed for hobbing.

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Field Report . . .

emphasis on advanced electronic products including inertial guidance systems for the Lockheed CF 104 fighter-bomber for the RCAF.

Allied Engineering Expanding

Allied Engineering & Production Corp, Alameda, Calif, has taken over a 75,000 sq-ft adjoining building for expansion of its manufacturing plant. Expansion involves a half-million-dollar investment. Company is a fabricator of industrial and hydraulic machinery and nuclear equipment.

Westinghouse Gets A-Sub Order

Navy's Bureau of Ships has awarded a cost-plus-fixed-fee contract totaling $12.3 million to Westinghouse Electric Corp, Pittsburgh, for design, development, and production of nuclear propulsion components for three atomic submarines. Major items to be supplied under the contract include reactor vessels, control drive mechanisms, main coolant systems together with their steam generators, and pumps and main loop piping.

B-L-H Wins Turbine Contract

Baldwin-Lima-Hamilton Corp, Eddystone, Pa, has been awarded a $6.3 million contract for supply of eight gigantic hydroelectric turbines for the Glen Canyon Dam power plant in Arizona. The English Electric Co of London was the low bidder at $6,214,552 but it didn't get the contract because Congress's Buy American Act states that if the bid of an American firm is within 6% of a lower bid by a foreign company a government agency can accept the higher American bid.

Climate Appeal

Miami-based General Development's Port Malabar Industrial Park—three miles south of Melbourne—has its second big electronics firm. Radiation Inc has already begun construction of a $5 million plant and another Melbourne firm, Soroban Engineering Inc, plans a $750,000 facility in the Park. Soroban designs and manufactures data processing control equipment and computer systems for high-speed communications networks.

Mallory Battery Co . . .

. . . has begun construction of a 64,000 sq-ft plant at Lexington, NC. Some 300 will be employed in production of small mercury batteries.

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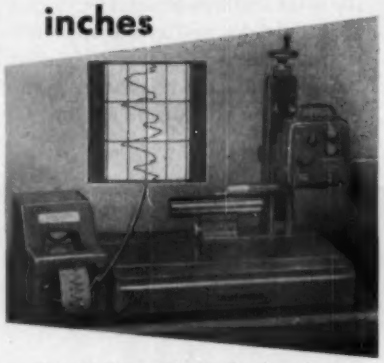

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Saybrook Plant, True Temper Corporation

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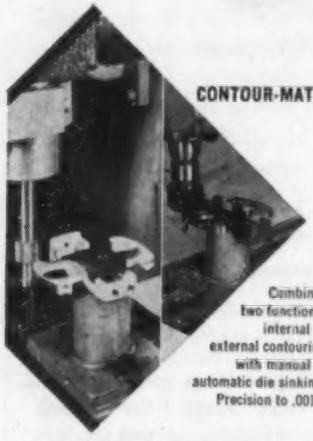

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New Ga Plant Opening in Rome

V E Anderson Manufacturing Co of Owensboro, Ky, has opened its new 52,000 sq-ft aluminum extrusion-window and door assembly plant at Rome, Ga. Costing more than half a million dollars, it's part of the firm's five-year expansion program. A 1500-ton capacity aluminum extrusion press is in operation and service and space facilities have been laid out for a second big press.

MEMOS

by BESS RITTER

The Parisians who lived in the 1780's had their own version of today's Automat restaurant. This place, called Café Mécanique, was furnished with a series of marble tables, each supported by two hollow columns. These columns extended down to the cellar where the food was prepared.

To order a meal the customer (a) pulled a chain which was attached to the selected column. This (b) rang a bell in the basement, which was a signal to an employee here to (c) open a valve on the table, evidently connected to a speaking tube. The customer could (d) speak into this valve and order his dinner. The food or drink request was then (e) placed on a dumbwaiter installed inside the column. When it reached the table the customer took it off and ate.

Since the proprietoress herself (evidently) preferred to be the only one to handle cash, money to pay for the meal wasn't placed on the dumbwaiter. Instead, the lady also served as a cashier, and communicated with the kitchen by speaking tube, whenever a dish was ordered and served up.

Another interesting wrinkle: Although food was offered and served, most Mécanique customers preferred to buy drinks instead.

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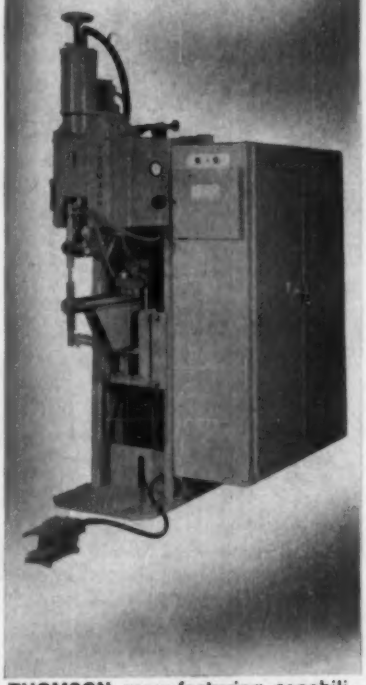

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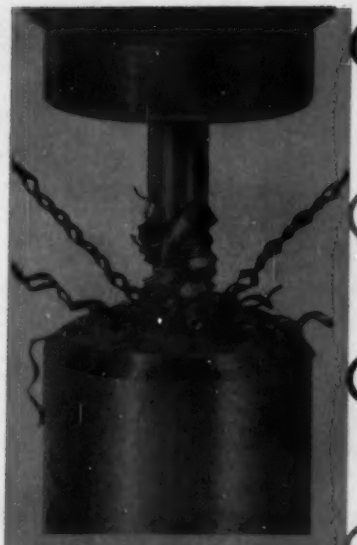

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Fast Spiral Fluted Taps are especially useful in cutting holes which are interrupted by slots, keyways or other gaps. The tap remains steady at all times because all of the tap lands are in contact with the sides of the hole even when a portion of a land is spanning the open space.

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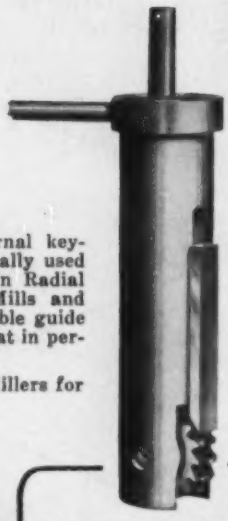

NATIONAL Keyseating Millers are mechanically simple in construction, sturdily built, designed for milling internal keyseats, faster and better. Although principally used in Drill Presses they can also be used in Radial Drilling Machines, Horizontal Boring Mills and Milling Machines. An exclusive demountable guide on body of Miller assures a straight keyseat in perfect alignment with axis of bore.

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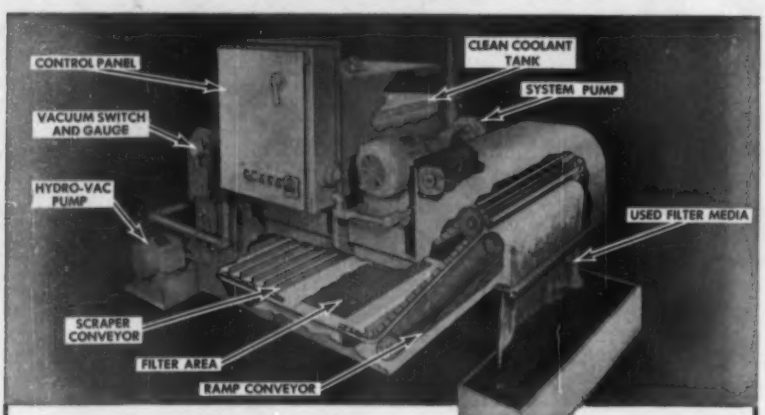

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MACHINES AND ATTACHMENTS

1 BLOW MOLDER—*F J Stokes Corp, 5500 Tabor Rd, Philadelphia 20, Pa.* 4-page bulletin 291 pictures and describes dual-manifold Model 853-1 for fully automatic, semi-automatic, or manual production of hollow plastic products. Unobstructed vertical-flow path makes it possible to mold long, deep items. Machine is supplied as a complete, integrated unit, including all controls, instruments, valves, and operating accessories. Clamping section is available separately for those who already have extrusion equipment.

2 GEAR SHAVER—*National Broach & Machine Co, 5600 St Jean Ave, Detroit 13, Mich.* 2-page illustrated catalog sheet CS60-1 describes improved Red Ring equipment and processes for shaving engine camshaft gears. Provides data on Model GCU Diagonal shaver. The Diagnoal shaving process, traverse angle, cutter selection, and process advantages discussed in detail.

3 LATHES—*Carl Hirschmann Co, 30 Park Ave, Manhasset, LI, NY.* Catalog covers Schaublin line of lathes with center heights of 3, 4, and 5 in. These building-block lathes are assembled at Hirschmann to meet exact requirements of of any particular job. This is made possible through the more than 900 standard items comprising the line. Thirty different headstocks for every purpose are stocked as are 15 different carriages, 7 tailstocks, 5 bed, various drives, and a large number of other accessories.

TOOLS AND ACCESSORIES

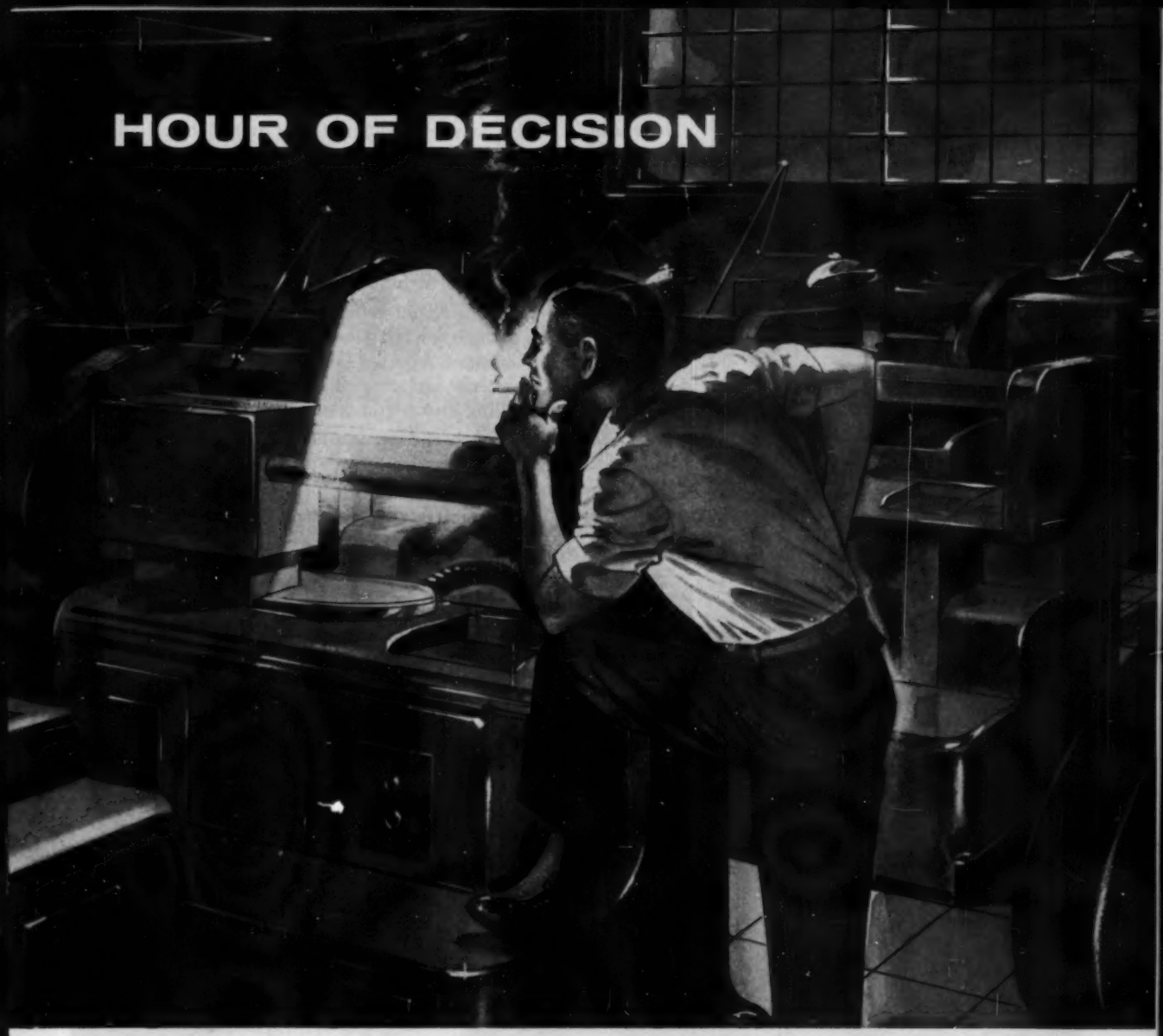
4 AUTOMATION EQUIPMENT — *USI Robodyne Division of US Industries Inc, Silver Spring, Md.* Literature describes the TransfeRobot, a precise, automatic parts assembler, machine operator, and production hand. Covers design and operation as well as simple means of programming and set-up which permits it to be switched from job to job in one-half hour. Applications include light assembly, secondary operations, and inspection.

5 BALANCING MACHINES—*Tinius Olsen Testing Machine Co, 307 Easton Rd, Willow Grove, Pa.* 20-page bulletin 60 covers two complete lines of static-dynamic balancing machines. Describes Olsen compensator and pivoted cradle machines including special adaptations for jet engines and components, automobile engines, and completely automatic balancing machines. Includes discussion of nature, causes, and

(continued on page 221)

"S-s-hut that thing off . . . I want to t-t-alk to you and I'm losing my plates . . ."

HOUR OF DECISION



IS THIS YOU? How many times, after the call bell stops clanging, the customers stop phoning, and people stop asking questions, do you walk into the quiet shop to face up to the really vital decisions?

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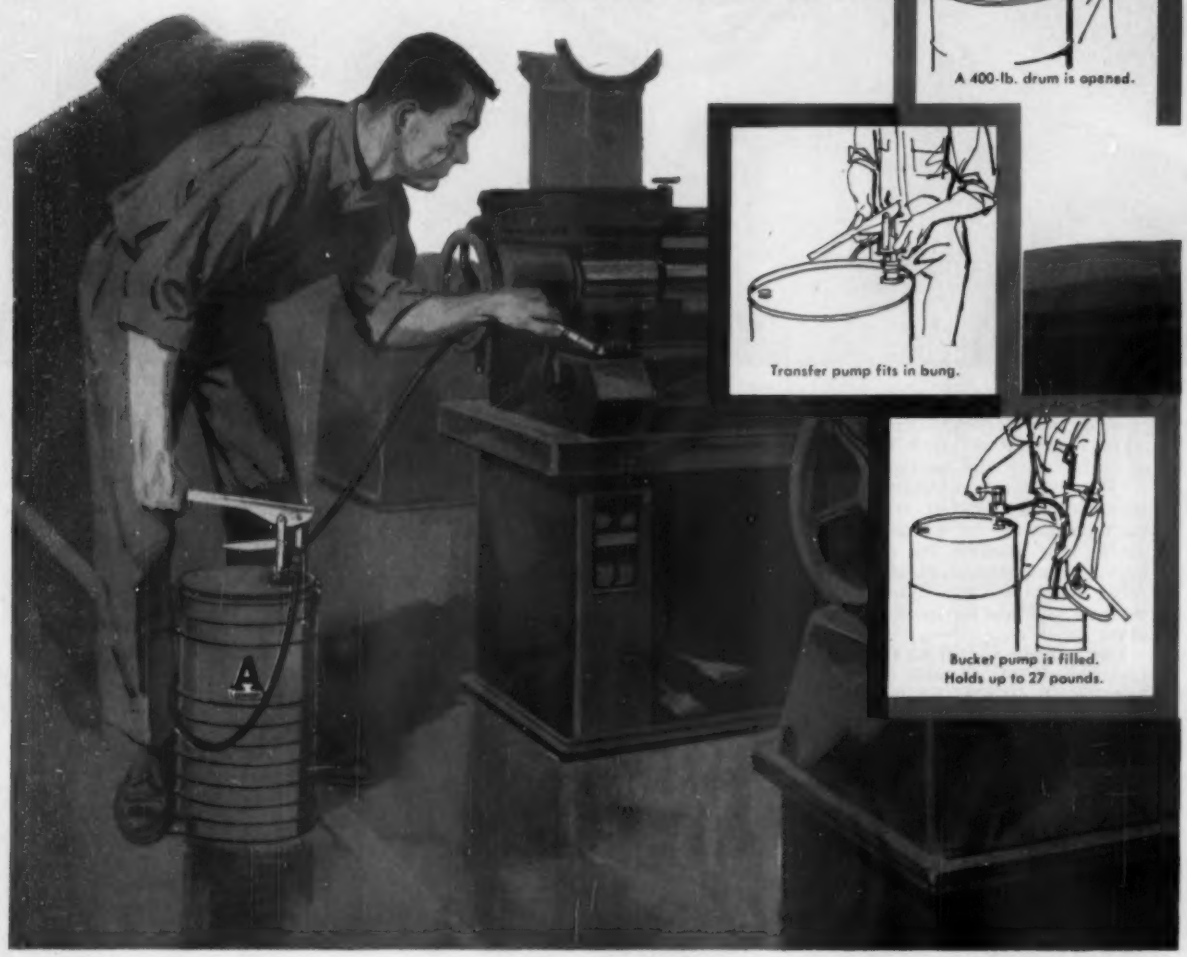

A 400-lb. drum is opened.

Transfer pump fits in bung.

Bucket pump is filled. Holds up to 27 pounds.

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correction of unbalance with descriptions and schematic diagrams of four different balancing methods—compensator, nodal bar, pivoted cradle, and electrical network.

6 NON-DESTRUCTIVE EQUIPMENT —*Philips Electronic Instruments, 750 S Fulton Ave, Mount Vernon, NY.* 12-page booklet contains engineering facts and specifications for many Norelco X-ray test units for radiography and fluoroscopy. Covers PG 100 lightweight portable, PG 140 low-intermediate portable, PG 200 high-intermediate portable, MG 150 and MG 300 constant potential installations, electronic fluoroscopy with image intensifier and closed-circuit TV, the PG 260 self-contained portable, and Portaspec, the Norelco portable X-ray Spectrometer.

7 SELECTED NATURAL DIAMOND GRIT—*Industrial Diamond Division, Englehard Hanovia Inc, 75 Austin St, Newark 2, NJ.* 20-page booklet for users of diamond grinding wheels provides detailed description of the recently introduced SND grit, both treated and untreated, its advantages, and the types of application where the material offers greatest benefits. Contains detailed tabular information relating particle shape, size, and efficiency to bond material, wheel speed and infeed in the grinding of cemented carbides, glass, stone, ceramic, concrete, tile, and other materials.

8 DIAMOND WHEELS — *Abrasive Wheel Dept, Manhattan Rubber Division, Raybestos-Manhattan Inc, Passaic, NJ.* Catalog M1501 describes complete line. Includes data on available grit sizes and diamond concentrations, wheel markings, suggestions for prolonging wheel service life, and ordering information on both resinoid bonded and new metal bonded diamond wheels.

9 GRINDING WHEELS — *American Emery Wheel Works, 1 Richmond Sq, Providence 1, RI.* Brochure on how to order American wheels includes standard markings for grinding wheels, shapes, abrasives, characteristics, grinding wheel recommendations for specific jobs, and a wheel speed conversion table. There are over 140 grinding wheel usage recommendations broken down into material and job classification with the suggested wheel, abrasive, and bond listed.

10 OSCILLOGRAPH—*Heiland Division, Minneapolis-Honeywell Regulator Co, 5200 E Evans Ave, Denver, Colo.* 36-page manual on the direct-recording Visicorder oscillograph contains 18 case history descriptions of how it has been used in widely

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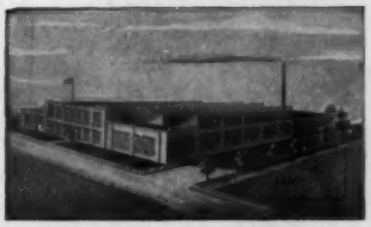

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different ways. Included are detailed reports on applications in providing high-frequency analog data in industry (from timing telephone switching sequences to checking the phase shift heat on resistance welders); missile component testing; drone surveillance; oil film thickness measuring of 67,500-kw generators; and nuclear instrumentation.

11 KENDEX THROW-AWAY INSERTS—*Kennametal Inc, Latrobe, Pa.* 2-page bulletin covers nine high-velocity machining applications of inserts made of Kentanium Grade K165 together with brief records of their comparative performance advantages. Applications include finishing operations on alloys of low machinability and on cast iron and mild steel. Also gives the most significant properties of K165 in relation to its performance and the fine finishes produced.

12 COLLETS AND COLLET FIXTURES—*Zagar Inc, 24000 Lakeland Blvd, Cleveland 23, Ohio.* 4-page bulletin contains illustrated descriptions of line of fixtures for use in small part milling drilling, tapping, grinding, and second operations. Collets for fixtures pictured as well as collet pads and blanks.

13 GAGES AND MEASURING INSTRUMENTS — *Cadillac Gage Co, PO Box 3806, Detroit 5, Mich.* 8-page booklet illustrates and describes complete line of Pla-Chek gages including the 6, 12, 18, 24, 36, and 48-in. models, plus data on the Cadillac Thread Analyzer and Super Chek. Gages are designed for use on the surface plate either away from or at the machine. Most of them can be set in 10 to 15 seconds and are guaranteed accurate within extremely close limits.

14 CUTTING FLUID—*Master Chemical Corp, Toledo, Ohio.* Brochure 460B gives information on characteristics and advantages of Trim, a chemical cutting fluid. Provides general data on coolants and cutting fluids used in grinding, drilling, and other operations.

15 TESTING INSTRUMENTS AND EQUIPMENT — *Custom Scientific Instruments Inc, 541 Devon St, Kearny, NJ.* 16-page catalog 60 contains illustrations and brief descriptions of 77 testers and production, control, and research equipment manufactured as standards. Included are abrasion testers; flammability-

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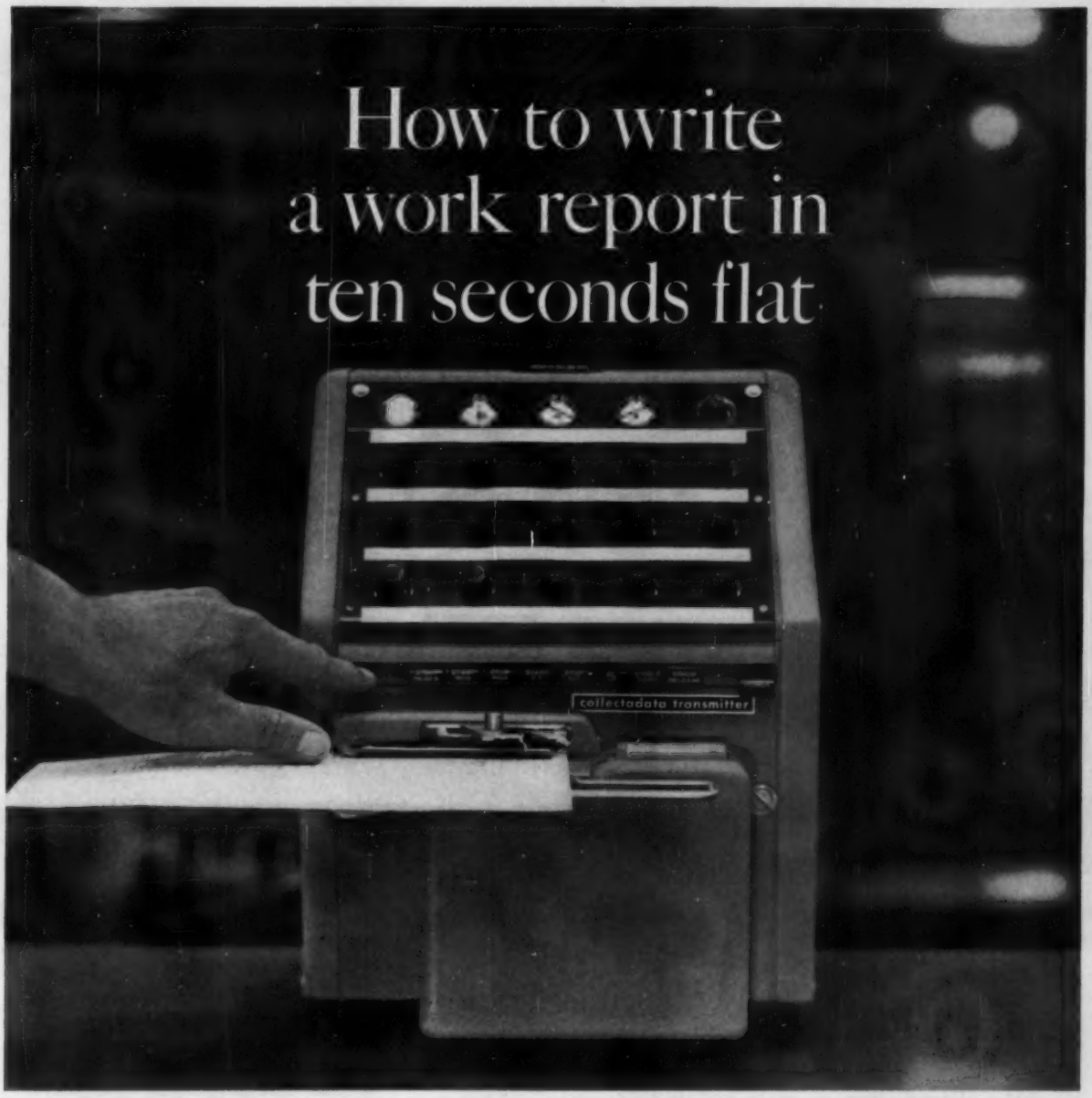

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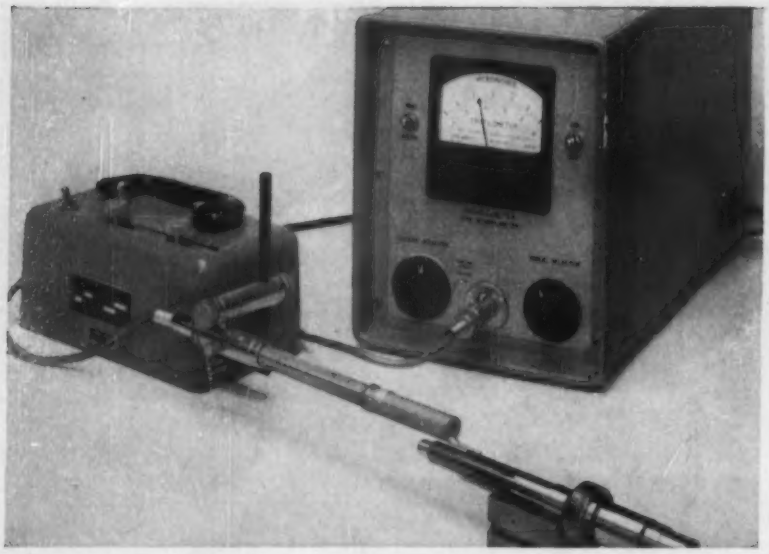

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Whenever you must precisely *know* the roughness of *any* production surface — quickly, dependably, in microinches (arithmetical or rms).

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Free Literature

To order any of these bulletins, circle corresponding number inside back cover.

ignition testers; thermal conductivity dielectric units; and thickness compression and recovery gages. Custom built equipment pictured and described.

16 MILLING CUTTERS AND BLADES —*Wesson Co, 1220 Woodward Heights Blvd, Ferndale 20, Mich.* 2-page bulletin TA-7888 provides information on line of throw-away insert milling cutters and new longer-life blade for Rigidcut milling cutters. Inserts in the throwaways are individually micro-adjustable so the cutters can be used for finishing as well as roughing.

17 GREASE ADDITIVE—*Elco Lubricant Corp, Jennings Rd & Denison Ave, Cleveland 9, Ohio.* 12-page Lube/Report No. 101 presents results of laboratory tests conducted to evaluate SCL Concentrate as a grease additive. Data shows a comparison of SCL sulfur saponifiable-lead naphthenate and MIL-L-002105 A additives. All data is reported in complete detail and includes photos showing moisture corrosion test comparisons.

HEAT TREATING AND WELDING

18 DIAL FEED WELDERS — *Taylor Winfield Corp, 1048 Mahoning Ave, Warren, Ohio.* 12-page brochure S-213 describes dial feed mechanism for dial feed resistance welders. Included are drawings and photos of the Geneva index mechanism plus graph showing recommended rate of indexing for various numbers of stations. Total of 28 case histories illustrate and discuss product, operation, and production rate of these welders which are particularly suited for assembly of smaller components.

19 FURNACE ATMOSPHERE ANALYZER—*Perkin-Elmer Corp, Norwalk, Conn.* 4-page brochure contains description of Model 184B process gas chromatography instrument for furnace and controlled atmosphere applications. Unit automatically performs a four-component analytical cycle every 10 minutes. Describes operation and installation, lists specifications and sensitivity limits.

20 WELDING NEW METALS — *Air Reduction Sales Co, 150 E 42nd St, New York 17, NY.* Form ADR 123, "Which Welding Process for the New Metals?", presents a comprehensive review of the problems involved in joining the newer metals and alloys used in aircraft and missile design such as PH stainless steels, ultra-strength steels, Rene 41,

"Sure, I can read blue prints. I can read any color printing you got, just as long as it's English."

NEW GIANT AT WORK on Double Diamond Gears

This huge, continuous, carburizing, hardening and draw furnace now permits even greater instrument control in heat treating DOUBLE DIAMONDS for maximum wear resistance and load-carrying capacity. So far as we can discover no more efficient furnace could be installed to achieve the quality characteristics our gear customers have come to expect.

At your request, our gear engineers would be pleased to describe this process in greater detail and to explain, as well, what our recently expanded facilities can mean in terms of this pledge: "DOUBLE DIAMOND Gears offer the advantages of lower installed cost and economical and dependable service on the job . . . gears that do credit to your product and reputation."

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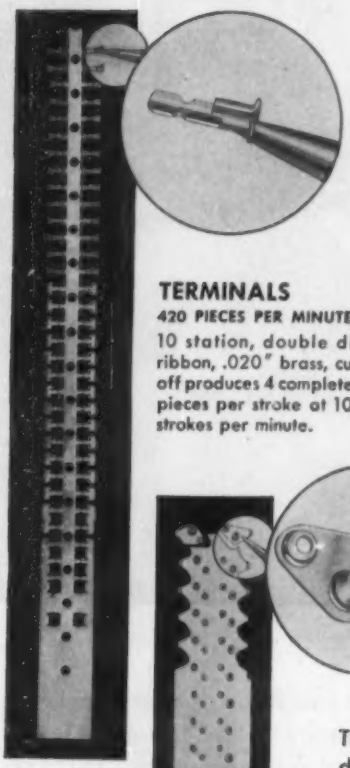
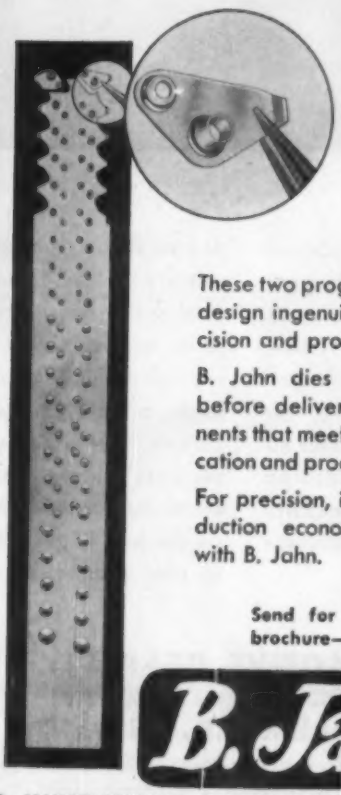


TERMINALS
420 PIECES PER MINUTE
10 station, double die ribbon, .020" brass, cut-off produces 4 completed pieces per stroke at 105 strokes per minute.



TERMINALS
200 PIECES PER MINUTE
15 station die ribbon, .032" brass, cut-off produces 2 pieces per stroke at 100 strokes per minute.

These two progressive die ribbons show design ingenuity that pays off in precision and production.

B. Jahn dies are Production Proved before delivery guaranteeing components that meet every assembly specification and product quality requirement.

For precision, ingenuity and mass production economy—produce the best with B. Jahn.

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THE B. JAHN MANUFACTURING COMPANY, NEW BRITAIN, CONNECTICUT

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beryllium, zirconium, molybdenum, tantalum, and columbium. Also contains tabular presentation of process data on four of these new metals.

21 RADIATION SHIELD VACUUM FURNACE—*General Electric Co, Schenectady 5, NY.* 4-page bulletin GED-3793 describes features and advantages of new refractory-free 4200 F unit for critical heat treating. Includes photos, ratings, and dimensions and table of typical applications. Other GE vacuum furnaces discussed.

22 SPIKE POWER WELDING—*Robotron Corp, 21300 W Eight Mile Rd, Detroit 19, Mich.* 4-page bulletin discusses spike power, a system of pulse power resistance welding. Method permits handling of many metals which have been difficult or impossible to weld including aluminum, vinyl-clad steels, and dissimilar metals, even if one has a melting point considerably lower than the low end of the plastic range of the other. Illustrations show how system differs from conventional resistance and capacitor discharge welding.

23 HELIARC CUTTING STAINLESS STEEL—*Jessop Steel Co, Steel Warehousing Division, 25th Ave at Cermak Rd, Broadview, Ill.* Illustrated folder outlines cost saving potential and lists metallurgical benefits of cutting stainless steel plate by the new tungsten arc process.

24 HELIWELD EQUIPMENT—*Air Reduction Sales Co, 150 E 42nd St, New York 17, NY.* 24-page catalog 2300 (form ADC 709G) covers complete line of manual, semi-automatic, and automatic Heliwelding (Airco's tungsten-inert-gas welding process) equipment and accessories used in conjunction with the process. Data included on two new manual holders and automatic heads, and a new manual welding kit.

25 ELECTRICAL STRIP HEATER SYSTEM—*J B Nottingham & Co, 551 Lexington Ave, New York 17, NY.* 4-page bulletin BL SH101 illustrates and discusses a method of preheat that permits quality welds on low-alloy high-tensile steels. Describes how underhead cracking and other weld defects can be avoided by preheat with a DurElec building block electrical strip heater system that provides controlled preheat for weldments of almost any size or shape.

26 BOX - TYPE RECIRCULATING FURNACE — *Sunbeam Equipment Corp, Meadville, Pa.* 4-page illustrated bulletin SEC-8 outlines advantages and design features of standard gas fired or electric unit that has an operating range of 300 to 1400 F. It can be used for drawing, annealing, tempering, and stress relieving

(continued on page 231)

"There's a man to see you from the Internal —ha, ha, ha—the new shop foreman is here!"

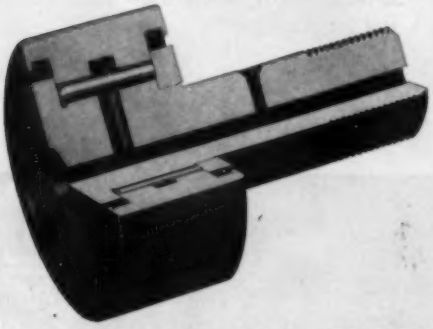
only McGILL® sealed *CAMROL*® cam followers give you . . .

effective sealing

prelubrication

high radial and shock capacity

in a full range of sizes



Effective sealing of the CAMROL cam follower against moisture, dirt, chips, etc. guarantees longer service life . . . reduces maintenance. This sealed construction retains lubricant and eliminates need for frequent relubrication, so often undesirable in cam action, guide support and track roller applications.

Special seals are built in at stud and flange ends. A black oxide finish on all exposed surfaces offers outside corrosion resistance. The channeled reservoir above the rollers in the outer raceway bore helps store reserve lubricant, sufficient in most cases for lifetime service. Relubrication is possible through convenient oil holes. The new SCF sealed CAMROL cam followers interchange with proven standard CAMROL cam followers. Standard stock with roll diameters up to 4" are available for both stud and shaft mounting.

For maximum bearing life where contamination is a problem, specify sealed CAMROL cam followers. Ask your McGill representative or our engineering department for recommendations.

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precision needle roller bearings

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CIRCLE 317 READER SERVICE CARD

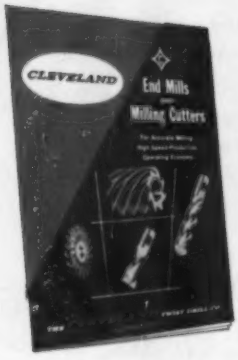
CIRCLE 318 READER SERVICE CARD ▶

NEW

Over a period of years we have continually enlarged and improved our line of CLEVELAND End Mills. Now, with the addition of the wide range of CLEVELAND Milling Cutters shown on the opposite page, you can specify a CLEVELAND Cutter for every application . . . and know you are getting lower cutter cost per cubic inch of material removed.

CLEVELAND Milling Cutters assure maximum metal removal per grind. Wide chip space between teeth enables these cutters to perform smoothly in the most difficult materials. Correct axial, radial rake and relief angles provide efficient operation under all conditions. Moreover, CLEVELAND Milling Cutters reduce regrinding time by requiring minimum amounts of stock removal when resharpening.

Take advantage of these time-saving, money-saving features. Specify CLEVELAND Milling Cutters on your next milling application!



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This 64-page illustrated book gives complete information on all types of CLEVELAND Milling Cutters—Plain, Side, Half Side, Corner Rounding, Concave, Convex, Woodruff Key Seat, Angle, Metal Slitting, Screw Slotting. Also full information on CLEVELAND End Mills. Ask for your copy.

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Your CLEVELAND Distributor can give you good service on CLEVELAND Milling Cutters and the complete line of CLEVELAND ◇ Quality Tools

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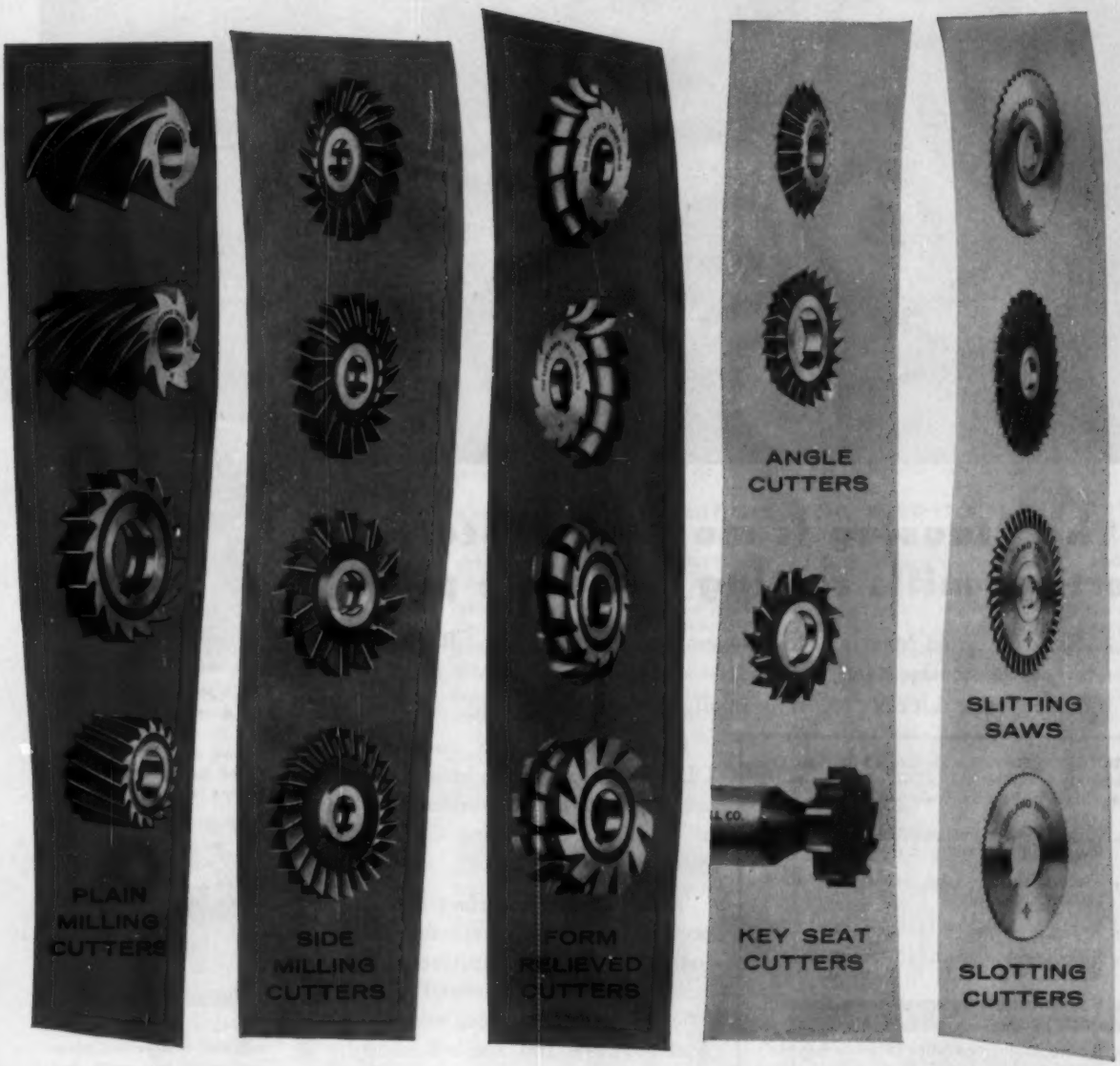

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"The Clausing is more accurate than vertical mills costing twice the price"*

So says Harold Meyers of the Meyers Machine Co., Grand Rapids, Mich. He goes on to say: *"and, we machine small parts up to 50% faster on our Clausing. You just can't beat it for small parts manufacturing."*

VERIFIED ACCURACY—Before it leaves the factory each CLAUSING MILL must pass rigid tolerance tests such as:

1. Top of table perpendicular to column ways within .0005" in 6" travel.
2. T-slots square with cross slide dovetails within .0005".
3. Table, parallel to turret within .001".
4. Spindle square with table, front to rear, within .001" T.I.R. in 5" circle.
5. Spindle taper (internal) runout within .0002" at spindle nose.
6. Table T-slots parallel to table dovetail ways within .0005" in 8" longitudinal travel.

Enthusiasm like this, on the part of CLAUSING users is virtually universal . . . points up the wisdom of getting *all* the facts concerning CLAUSING before buying *any* miller.

The Clausing is perfect for general production, pattern, experimental and tool room use. It is sensitive, versatile, accurate, easy to get around . . . highly efficient on *every* job using small cutters. And the price, too, spells economy:

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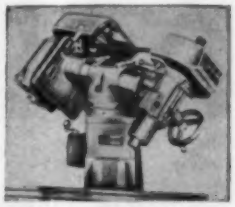
The high precision spindle and drive have 7 ball bearings . . . hardened spindle. Ground and hard chrome plated quill has full length bearing in head.



The spindle head can be swiveled in a vertical plane and set at any angle, and turret rotated in a horizontal plane making it possible to machine at all angles with one set-up.

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of both ferrous and non-ferrous alloys. Both small and large parts may be compactly loaded and heated under accurate temperature control.

27 WELDING FILLER RODS—*National Cylinder Gas Division, Chemetron Corp, 840 N Michigan Ave, Chicago 11, Ill.* Comparison chart (N-126) lists 28 NCG rods for use in welding nine different metals, together with competitive brands. Gives names and numbers of rods sold by NCG and by 22 other major suppliers; illustrates and describes each of 10 different fluxes made by NCG and gives a guide for ordering the right amount of flux for the rod to be used.

PLANT SERVICE EQUIPMENT

28 VAPOR SPRAY DEGREASERS — *Ramco Equipment Corp, 1373 Lafayette Ave, New York 59, NY.* Illustrated bulletin 100 provides information on units for removal of grease and oil from metal parts of any shape or size. Chart lists dimensions, solvent capacity, work load and other specifications for nine models which may be heated by gas, steam, or electricity.

29 FINISHING MATERIALS — *MacDermid Inc, Waterbury, Conn.* 2-page technical data sheet 100 is a usage and instruction sheet that provides information on MACro No. 1, a dry chromate base salt used in water solution to produce a corrosion resistant coating on magnesium. Product can be used as a final finish or as a paint base. Coatings, which can be applied by a short immersion spray or with a swab, vary from tan to bronze, the deeper color having a higher corrosion resistance. 2-page technical data sheet No. 99 describes MACro Brite L-10, a leach-type bright chromate for zinc and cadmium that eliminates handling of liquid acid in chromating. It is a powdered material, dissolved in water, and used to produce clear bright or irridescent bronze chromate finishes.

30 MACHINE LEVELER—*Barry Controls Inc, 700 Pleasant St, Watertown 72, Mass.* 4-page bulletin 60-05 pictures and describes the Serva-Levl Mount, a pneumatic servo system that operates as a non-deflection device to maintain absolute height. It floats each support point on a cushion of air so that machinery is

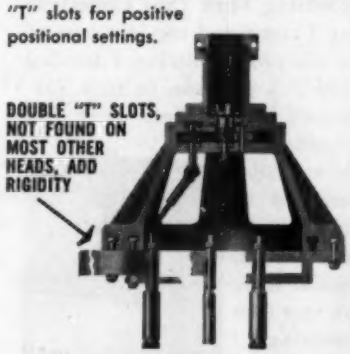
"No, I didn't get this suntan in Florida. You still have your safety goggles on."

JARVIS UNIVERSAL JOINT MULTIPLE SPINDLE HEADS

* For example, you can add to the basic head one or more of 20 optional accessories (such as Spindle Assemblies, Spindle Cluster Plate, Base Plate, Guide Rods, etc.) to meet the requirements of a particular job. With Jarvis Heads you have a greater selection of parts and accessories. A buy-only-what-you-need, custom-built head without having to pay the high cost of regular custom designed heads. Universal joints are of an advanced structural design which feature: low deflection rate; superior fatigue resistance; greater overload capacity and longer life. Joints have a snap-on feature and can be slipped off the spindle without use of tools.

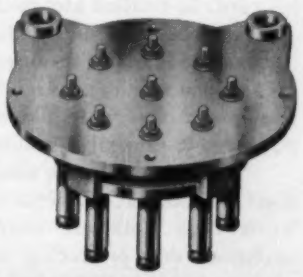
EXCLUSIVE JARVIS FEATURES

Cut-away view (below) reveals high strength, light weight aluminum alloy castings, heavily ribbed for durability; gears and spindle drivers run in ball bearings, have more than thrust load capacities; idler gears mounted on heavy duty needle bearings running on specially heat treated steel studs; adjustable outrigger arms locked in position with threaded studs located in double "T" slots for positive positional settings.



NO NEED TO INVENTORY SEVERAL FIXED HEADS

Head converts easily to a fixed head by adding a Jarvis Spindle Cluster Plate (shown below) which can be jig bored, by you or by us, to locate spindles to suit hole spacing required. Cluster Plates will aid in reducing setup time and will assure correct setup each time.



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26 Pease Ave., Middletown, Connecticut

____Send U.J. Multiple Spindle Head Catalog

Name _____ Title _____

Company _____

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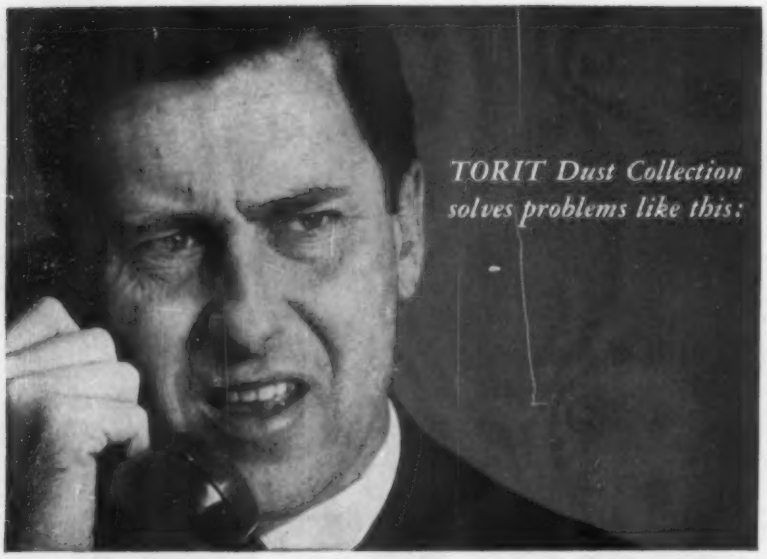


"6 MEN OUT AGAIN TODAY?" "WHY?"

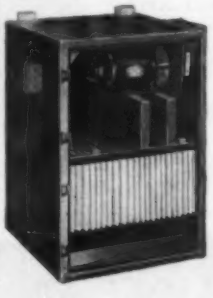
"I was on the receiving end of that question. And I knew what the boss was driving at. Production-wise, we couldn't stand our current rate of absenteeism. Even the men on the job were dragging their feet. To show you what I mean: we had just lost one of our best customers. Reason: one too many late shipments.

"Logically, when sickness strikes, you consult a doctor. Which is what I did. Without actual examinations, he couldn't diagnose the trouble. But he did give me the clue when he asked, 'How are your working conditions?'.

"Frankly, our plant is dirty. Or better put, dusty. With grinding machines running 24 hours a day, how could it be anything else? With that thought, I remembered. A salesman had been in my office just the other day talking about dust. I had too many production headaches at the time to hear him out. But I kept his card. So I called him back.

"He was from Torit. He was selling Torit Dust Collectors . . . machines that trap dust. When I compared the low cost of his equipment with the high cost of our production lag, I decided it was worth a try. So I bought one . . . just one, to start, for $285.00. We installed it ourselves on a key machine.

"The change in the man operating that machine sold me. Within a month, we had a Torit Dust Collector system attached to seventeen dust-producing machines in the plant. As a result, the air in our plant is clean, the way it should be. Our absentee rate is no longer a problem. Our production rate is at top speed. And you know something? I feel better myself!"



Is dust doing you dirt? For complete facts on dust damage . . . and how to control it . . . write:

TORIT manufacturing company

Dept. 424, 1133 Rankin St., St. Paul 16, Minn.

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literally airborne. The Mount maintains level within 0.0005 ipf of length of any precision machine, absorbing vibration and shock at the same time.

31 STRAINER GUIDE — *Tate Engineering Inc, 516 S Eutaw St, Baltimore 1, Md.* 88-page handbook of simplified selection and sizing contains a compilation of reference data for the layout of fluid flow systems and sizing of strainers, tabulated results of testings, and valve and pipe selection information. Contains over 100 illustrations of pressure drop, temperature, and viscosity charts in addition to engineering drawings of the full range of strainers.

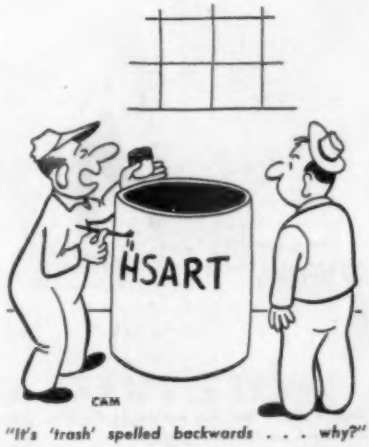
32 BELT-DRIVEN TUBEAXIAL FANS —*Propeller Division, Robbins & Myers Inc, Springfield, Ohio.* 8-page bulletin 625 covers the 30 to 60-in.-dia units of newly improved line of Type BT and BTV fans. Air deliveries range up to 85,000 cfm. Describes construction features and gives application details for various polluted and high temperature atmospheres these fans are designed to handle.

33 AIR AND VACUUM PUMPS — *Leiman Bros Inc, 102 Christie St, Newark 5, NJ.* 32-page catalog 460 describes rotary positive air pressure and high vacuum pumps, gas boosters, and air motors. Includes construction details, dimensions, capacities, performance curves on all pumps, plus engineering and application data.

PARTS AND MATERIALS

● POWER TRANSMISSION EQUIPMENT—*Dodge Manufacturing Corp, Mishawaka, Ind.* 468-page illustrated general engineering catalog describes all products in company's line of mechanical power transmission equipment. Both new and established products are covered with drawings, dimensions, weights, prices, technical data in tabular form, and helpful selection and application information. Separate section on general engineering data is included as well as a 7-page general index. Request direct on company letterhead.

34 WORM GEAR REDUCERS—*Link-Belt Co, Prudential Plaza, Chicago 1, Ill.* 66-page Book 2824 illustrates and describes new line of fan-cooled units in 25 types and over 135 sizes. They are

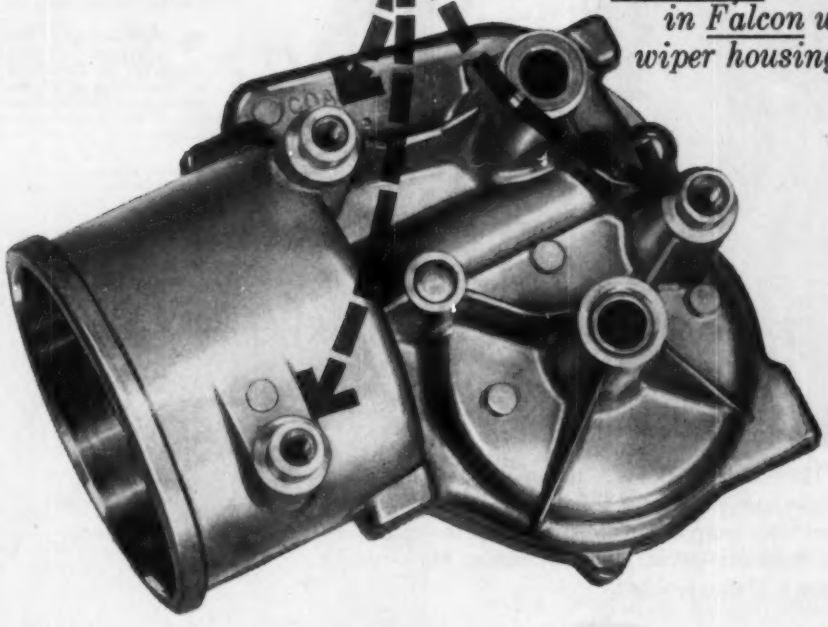


"It's 'trash' spelled backwards . . . why?"

FORD GAINS 500% IN TOOL LIFE

BESLY X-PRESS TAPS
Speed-form internal threads in metals such as copper, brass, die castings, aluminum, lead, leaded steels and other ductile materials. They are available in standard tap sizes and various styles for through or bottoming holes. Patent No. Re. 24,572. Other patents pending.

when Besly X-Press® Taps speed-form internal threads in Falcon windshield wiper housing!



Ford Motor Company's *Falcon* will give you good forward vision in rain, snow or sleet with its powerful windshield wiper.

Besly X-Press Taps, in a Kingsbury 3-spindle machine, tap directly into three cored holes in the Falcon's aluminum die cast windshield wiper housing. Drilling operations were avoided. Production is continuous. The Besly X-Press Tap produced as high as 50,000 tapped holes before replacement—thus offering increases of approximately 500% in tool life over conventional cutting-type taps. *Speed-forming* makes stronger, burnished internal threads, without cutting. There are no chips to load the tap in bottoming holes such as these. And faster cycling speeds production!

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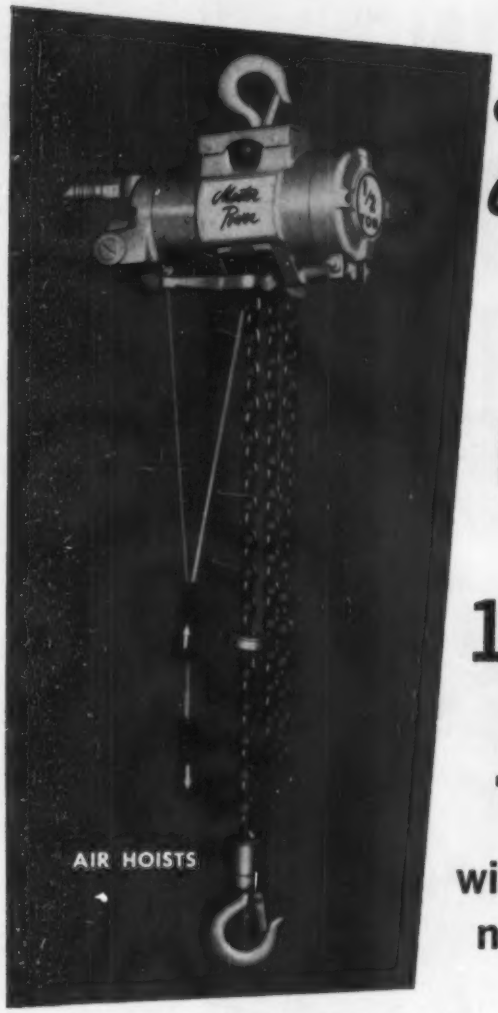

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available in ratios ranging from 5:1 to 3600:1 with torque ratings up to 135,000 lb-in. and hp ratings up to 150. Applications illustrated. Selection data includes rating tables arranged according to speed as compared to ratio; thermal input and mechanical output torques are shown for every speed and ratio for each reducer size.

● BEARINGS — *Kaydon Engineering Corp, McCracken St, Muskegon, Mich.* 28-page booklet, "Selected Engineering Drawings for Mounting Reali-Slim Bearings," presents new concepts for applying thin-sectioned large bore ball bearings to equipment designs. Installation drawings illustrate how these thin bearings save weight, space, and cost. Includes specifications and prices for the new ball radial type CP Reali-Slim bearings available in six series with ⅛ to 1-in. width and cross section. They are offered in 90 standard sizes with 4 to 12-in. bore in each of the six series. Request direct on company letterhead.

● MAGNETIC DRIVES — *Tormag Products Division, Gleason Reel Corp, 740 N Plankinton Ave, Milwaukee 3, Wis.* Catalog TP-160 covers operating principles and performance characteristics of new permanent magnet drive. Applications illustrated; solutions of many types of drive problems involving high inertia starts, excessive loads, extended full stall included. Request direct on company letterhead.

35 MOTOR APPLICATION GUIDE—*Century Electric Co, 1806 Pine St, St Louis 3, Mo.* 16-page bulletin 270B, new 1960 guide, outlines Century motor characteristics and includes up-to-date information on designs.

36 CAST HEAT AND CORROSION RESISTANT ALLOYS—*Alloy Casting Institute, 1001 Franklin Ave, Garden City, NY.* 12-page Technical Publications List lists 46 papers, articles, reprints, and data sheets which have resulted from the Institute's informational program. Literature available on stainless and heat resistant castings is described (including publication source) under the following categories: alloy selection; applications; research; engineering data; fabrication; foundry practice; metallurgical structure; properties; testing methods; and such general topics as purchasing of high alloy castings.

37 AIR AND HYDRAULIC CYLINDER—*Tomkins-Johnson Co, 2425 W Michigan Ave, Jackson, Mich.* 16-page bulletin SQ-3-60 covers the increased range of the T-J Squair Head air and hydraulic cylinder. Includes data on available bore sizes, rod dimensions, allowable strokes.

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COOLTEX, the *new* chemical grinding coolant, gives you better finishes because it keeps the work *cooler* . . . keeps the wheel from loading. Actually lets you use a *finer* grit! COOLTEX is transparent, so you can *see* the work — and it keeps machines noticeably cleaner. Your Texaco Lubrication Engineer is mailing COOLTEX idea postcards now. Watch for yours. Texaco Inc., 135 East 42nd Street, New York 17, N. Y.

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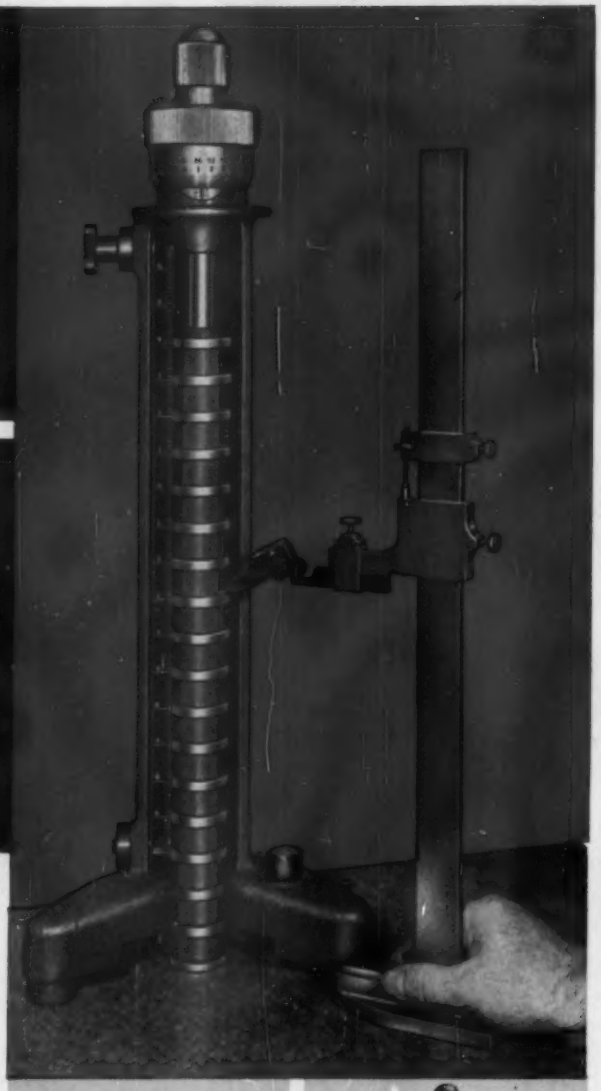

See How PLA-CHEK Cuts Inspections from Minutes to Seconds

Notice the wrist light photos above. Just a turn of the Micrometer thimble and PLA-CHEK is set. Far fewer motions, far less time . . . and guaranteed accuracy to .00005″ throughout this PLA-CHEK'S entire range. No gage blocks or reference surfaces to touch—body heat can't affect it. Setting time 10 seconds . . . inspections in 1/5 the time of older methods. That speed and accuracy is being proved daily in thousands of installations throughout industry.

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COMPLETE RANGE OF SIZES

PLA-CHEK Gages are available in a full range of sizes to meet every inspection or surface plate layout requirement. Models are: The easily portable 6″ and 12″ sizes and the 18″ size (shown above) are guaranteed accurate to .00005″ throughout their entire range, and the 24″, the 36″ and the 48″ sizes are guaranteed accurate to .0001″ in any 24″ length or .0002″ over their entire range.

PRECISION RISERS

Built with the same precision as the gages themselves, PLA-CHEK Gage Risers may be used to extend the usefulness of every PLA-CHEK Gage from the smallest to the largest size. Available in 6″ height for 6″, 12″, 18″ PLA-CHEKS . . . 12″ height for 24″, 36″, 48″ models.

MICROMETER THIMBLE

Is graduated to .0001″ and provides dimensions between 1″ steps on measuring bar. Measuring bar of the 18″ model (as illustrated) and larger models, can be adjusted to enable the user to take readings up or down relative to a center line or other reference line on the work.

Cadillac **GAGE COMPANY**

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Verson Allsteel Press Co, Chicago, has appointed **Melvin D Verson** (left) president and chief operating officer for the company. He has been serving as vice president, administration. **Jack Novak** (right), executive vice president, has been named, in addition, secretary of the corporation. **David C Verson,** board chairman, will function as chief executive officer

Brown & Sharpe Manufacturing Co, Providence, RI, has elected **Willard H Spence** vice president and general manager of the Industrial Products Division. Mr Spence will continue for the present as managing director of Brown & Sharpe Ltd, manufacturing subsidiary in Plymouth, England

NAMES IN THE NEWS...

R-O Manufacturing Co, Madison Heights, Mich, producer of R-O form relieving equipment, has promoted **Elwood Hemlin** from factory manager to vice president.

Chrysler Corp has named **Richard D Morrison** purchasing agent for materials and services purchasing. He was formerly purchasing agent for raw materials.

Allis-Chalmers has promoted **R L Carlstein** from production control manager to manager of manufacturing engineering at the West Allis Works.

Le Roi Division, Westinghouse Air Brake Co, Milwaukee, has appointed **Harry A Zaruba** manager of its Cleveland plant. He was formerly manager of manufacturing at the Milwaukee facility.

Allison Division of General Motors has named **Edgar G Davis** manufacturing manager, transmissions operations. Former manager of the bearings department, he replaces **William E Goohs,** now assistant manager of manufacturing, aircraft engines operations.

ACF Industries Inc has appointed **Kennard F Miller** general manager of the Carter Carburetor Division. He was previously manager of manufacture.

Buffalo Forge Co has named **Charles W Lockhart** vice president, sales. He moves up from the post of sales manager of the Air Handling Division.

Brubaker Tool Corp, Millersburg, Pa, has appointed **A William Tilder** general manager of the **Morton Machine Works Division,** manufacturer of fixture clamps and components. Mr Tilder was formerly general manager of Acromatic Tool Co, Detroit.

Budd Co has appointed **Nelson R Droulard** executive engineer of research and development in the Automotive Division. He will be headquartered in the Detroit plant.

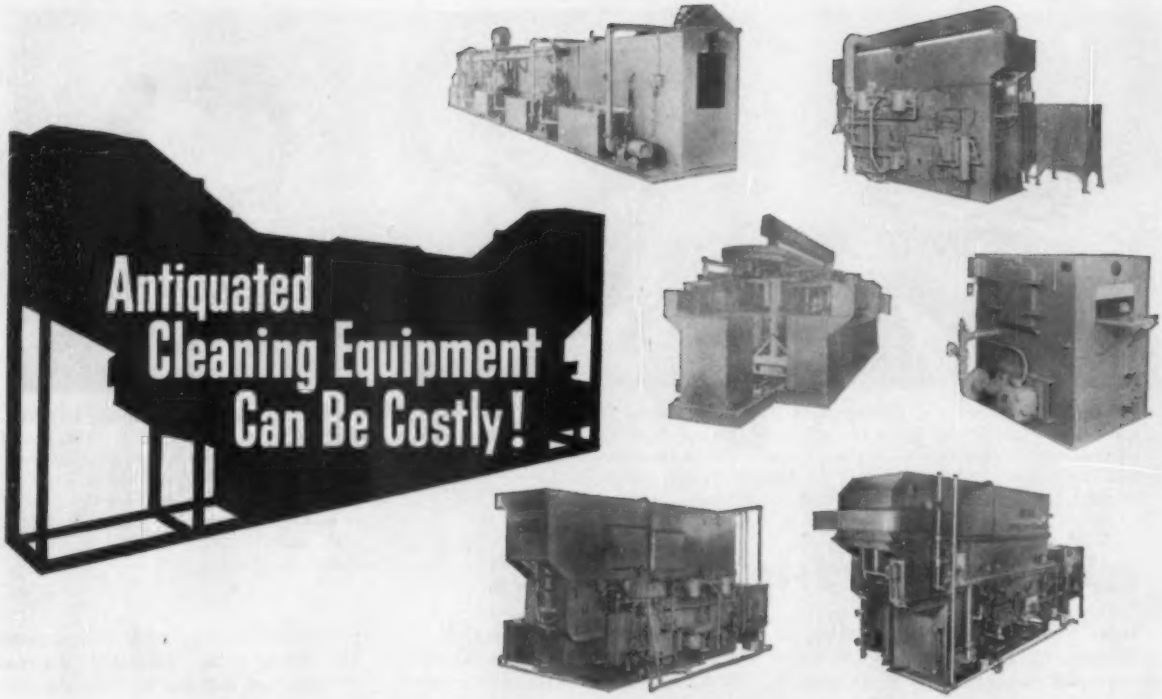
Bay State Abrasive Products Co, Westboro, Mass, has appointed **John R Boudreau** manager of a newly defined West Coast district which includes the present southwestern and west coast sales districts of the organization. He has been serving as manager of the southwestern district.

Nicholson File Co of Canada Ltd has elected **Frank H Briden** president and general manager. He has been vice president of the Canadian firm,

LeBlond Machine Tool Co, Cincinnati, has promoted **Henry J Bruck** from sales engineer to the post of manager of crankshaft and boring lathe sales

Lapointe Machine Tool Co, Hudson, Mass, has promoted **Frank J Kenney** from assistant sales manager to sales manager

Holo-Krome Screw Corp, Hartford, Conn, has elected **Harold A Neff** vice president and general manager. He has been a vice president since 1946



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It is no accident that the Detrex nameplate is found on more cleaning equipment in more metal-working plants than any other—*by a wide margin.* Detrex has had more than 30 years' experience in designing this equipment—has the most complete and modern facilities for producing it—has the largest and most expert field force to help install and service it. And now you can lease any of your cleaning equipment requirements from Detrex. Whether you need a machine for degreasing, washing, rustproofing, phosphate coating, paint-bonding or paint stripping—whether you require equipment that is large or small—whether you desire a manual or automated operation—Detrex can supply your needs exactly and follow through with the service that means complete satisfaction.

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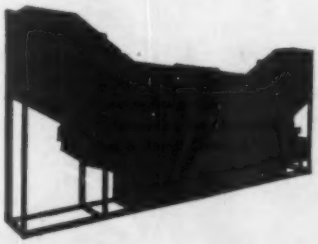
- Aluminum Treating Compounds
- Alkali and Emulsion Cleaners
- Rustproofing Materials
- Extrusion and Drawing Compounds
- Spray Booth Compounds



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NAMES IN THE NEWS . . .

a wholly owned subsidiary of Nicholson File Co of Providence, RI, since 1953.

Hughes Aircraft Co has appointed **Donald F Davern** project manager of industrial control systems. The industrial systems division designs and produces numerical machine tool controls and other electronic instruments and devices for industrial uses. Mr Davern was formerly manager of planning at the Hughes Tucson, Ariz, missile manufacturing plant.

Double A Products Co, Manchester, Mich, manufacturer of hydraulic control valves, has appointed Vice President **John Pippenger** director of sales of the company which is a subsidiary of Brown & Sharpe Mfg Co. **Ronald Loup,** assistant chief engineer, succeeds Mr Pippenger as chief engineer. **Peter Olmsted** has been named vice president, research and development.

Globe-Wernicke Industries Inc, Toledo, has elected **John H Pautz** vice president of the company and general manager of its **City Machine & Tool Co** division. He succeeds **Peter Peterson** who has retired after heading City Machine for many years. Mr Pautz was formerly plant superintendent and assistant to Mr Peterson.

Electric Autolite Co, Toledo, has assigned Vice President **Lawrence L Garber** to the president's staff to work principally in the areas of manufacturing, properties, and capital equipment. He was previously head of the company's battery division.

Western Electric Co has appointed **Fred B Smith** as a vice president of the firm. Formerly manager of the Hawthorne Works in Cicero, Ill, he will now head the company's eastern manufacturing area which includes facilities at Kearny, NJ; Allentown, Pa; and Merrimack Valley, Mass.

Cleveland Graphite Bronze Division, Clevite Corp, has promoted **W D Cowgill** from Detroit district sales manager to general sales manager of the division, producer of sleeve bearings and bushings.

Tumb-L-Matic Inc, Stamford, Conn, has named **Joseph M Ashmore Jr** vice president, purchasing. He was formerly associated with SKF Industries Inc, Philadephia.

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ACCURACY
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- Automatic positioning can be changed instantly to manual operation
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MBI has engineers available for consultation, guarantees service by factory trained staff, and stocks spare parts in New York.—Join the long list of leading aircraft and manufacturing plants throughout the United States which are using the horizontal optical jig borer.

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PORTABLE POWER TOOLS

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Studies show that operation of inefficient portable power tools probably fritters away more production . . . wastes more payroll dollars than anything else in industry today. Yet, even in the best-run plants, this fact is often ignored or overlooked by an otherwise-alert management.

How much production are *you* losing this way? Just how efficient are your portable tools, how do you find out, and what's the most economical way to keep them at peak performance?

You can get all the answers in Ingersoll-Rand's new illustrated guidebook to more efficient power tool operation. Write for your free copy today! With it you'll get a handy, easy-to-use *Dividend Computer* for estimating how big a Dividend on Payroll Dollars you can earn in your plant in just one year with Planned Annual Retooling. Ingersoll-Rand, 11 Broadway, New York 4, N. Y.

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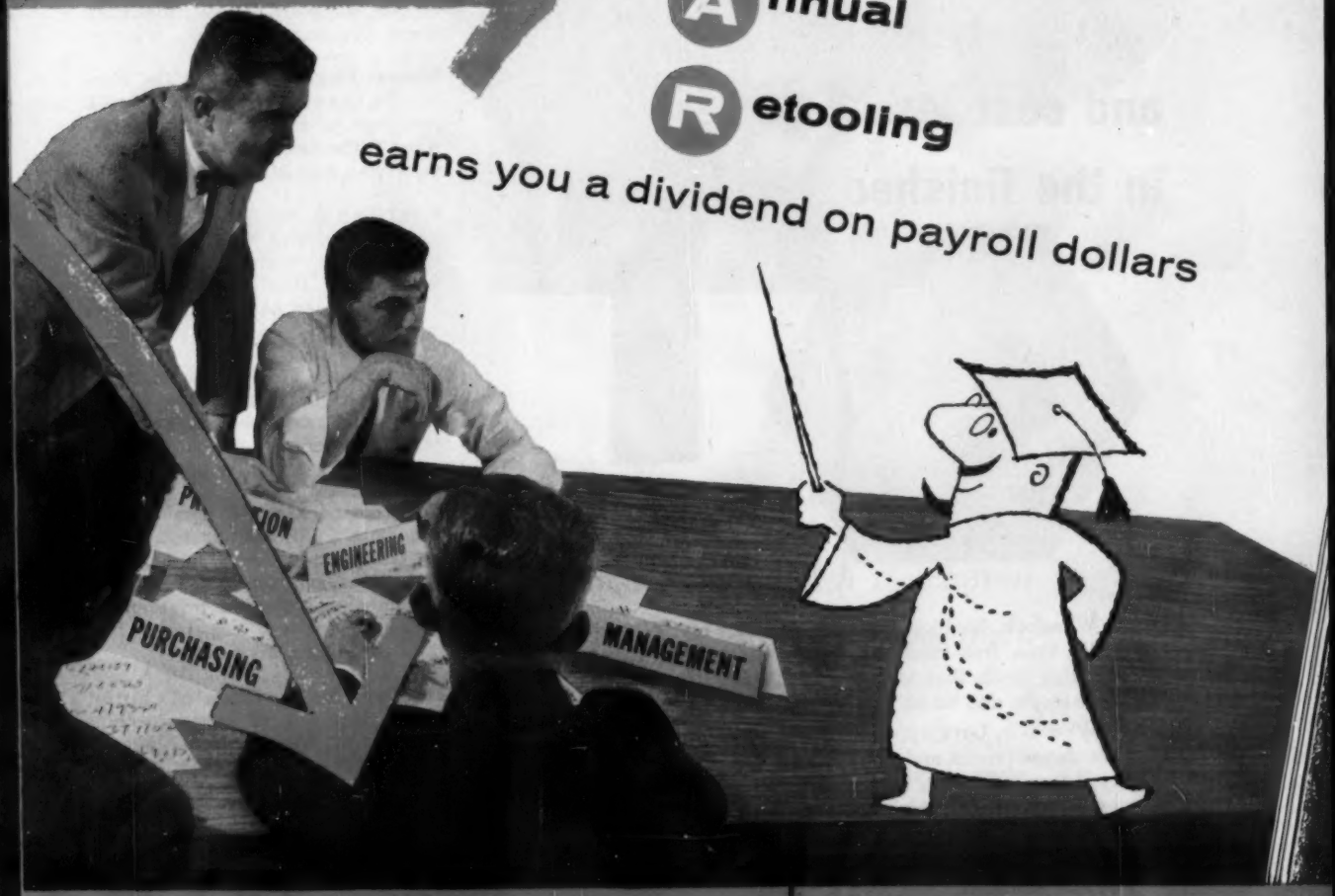

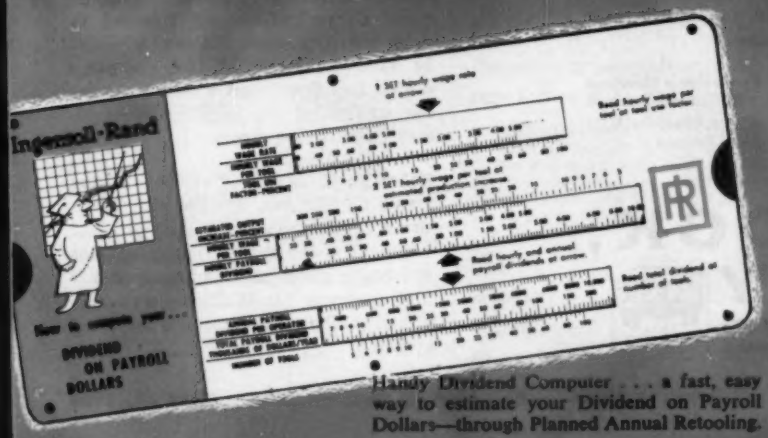

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Wheelock, Lovejoy, for many years the pioneer in the development and application of 4140 and 4150 type free-machining alloy steels, offers you the most extensive stocks anywhere, in all W-L warehouses.

Available variety of 4140/50 type free-machining stock includes round, square, flat, billets, and forgings to specifications.

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STEEL SERVICE CENTER INSTITUTE

NAMES IN THE NEWS . . .

Bendix Aviation Corp announces that **Charles E Heitman Jr,** former president of the Carter Carburetor Division of ACF Industries, has joined the staff of the executive vice president of Bendix. Mr Heitman will be responsible for major manufacturing and organizational functions in the divisional and interdivisional areas.

H K Porter Co has appointed **Roland H Wilson** works manager at the Riverside, NJ, plant of Riverside-Alloy Metal Division.

Thomas Flexible Coupling Co, Warren, Pa, has elected **Richard H Crook** president to succeed the late **Millward T Thomas,** founder of the company who died March 13.

Ferry Cap & Set Screw Co, Cleveland, has elected **Dan J Cantillon** vice president in charge of industrial sales. Vice President **William H North** has been named general sales manager.

McLaughlin Co, Birmingham, Mich, fastener manufacturer, has elected **Robert B Ryan** president. **Robert D Martin,** secretary-treasurer, succeeds Mr Ryan as vice president.

Consolidated Electrodynamics Corp, Pasadena, Calif, has appointed **Robert H Garretson** executive vice president. Mr Garretson joined CEC last December as group vice president responsible for the company's four data processing divisions.

Hershey Metal Products, Derby, Conn, producer of screw machine parts, has appointed **William R Knowles** sales manager. Mr Knowles was formerly associated with New Britain Machine Co as sales manager of the Precision Products Division.

Applied Dynamics Inc, Ann Arbor, Mich, subsidiary of Bowmar Instrument Corp, has elected **Edward G Schwarm** president. He was formerly vice president of the company which has developed a desktop analog computer for smaller research and engineering firms.

Fabri-Tech, a subsidiary of **F Jos Lamb Co,** Detroit, has promoted **Andrew J Waitkins** to the post of chief engineer. Company manufactures automatic parts handling components and systems. Mr Waitkins was previously sales engineer, parts handling systems.

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valves

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airline filter-lubricators

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Undercoat of Oakite CRYSCOAT adds to the looks and life of finishes

From toys to tractors, painted metal products look better and last longer with Oakite CrysCoat under the paint.

CrysCoating—the conversion of a steel surface to a phosphate surface—creates a perfect base for paint adhesion. Paint goes on in a smooth, serviceable coat. Once on, it stays on.

At the same time, a CrysCoated surface prevents the formation of rust . . . even prevents rust spreading from a deep scratch. Both metal and paint are safeguarded. The product looks better, lasts longer.

Oakite has a CrysCoat process to fit every requirement—for iron phosphate or zinc phosphate coatings, for spray washer or for tanks. Is your particular problem one of economy? Durability? Production bottle-neck? For a helpful answer, ask your local Oakite man. Or write for details to Oakite Products, Inc., 26H Rector Street, New York 6, N. Y.

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years' leadership in industrial cleaning

NAMES IN THE NEWS . . .

American Foundrymen's Society has elected **Norman J Dunbeck** president for 1960-61. Mr Dunbeck is vice president, International Minerals & Chemical Corp, Skokie, Ill. New vice president of the Society is **Albert L Hunt**, executive vice president of Superior Foundry Inc, Cleveland.

Chromalloy Corp has named **John L Ellis** vice president. He has also been named general manager of the **Sintercast Division**, Yonkers, NY. Mr Ellis was a co-founder of Sintercast in 1947 together with the late Erwin Loewy and Dr Claus Goetzel.

Van Norman Industries Inc, has named **Charles B Eisenhauer** vice president of the Electronics Division at Manchester, NH. He will also continue as general manager of the division plant.

Coated Abrasives Inc, Detroit, has named **Robert C Dickey** vice president and general manager. He was formerly plant manager at Michigan Abrasive Co.

Smith-Corona Marchant Inc, Oakland, Calif, has appointed **John E Wilson** to the post of manager of manufacturing of the Marchant Division. Mr Wilson moves up from the post of plant manager and now assumes responsibility for all factory operations at the Oakland plant which manufactures calculators and adding machines.

Raytheon Co, Waltham, Mass, has elected **Charles F Adams** to the newly created post of board chairman and **Richard E Krafve** president of the electronics firm. Mr Adams has been president of the company since 1948. Mr Krafve, former vice president of Ford Motor Co, who joined Raytheon in April 1959 as group vice president, commercial, was elected executive vice president last September.

Motor Wheel Corp, Lansing, Mich, has named **Robert J Derleth** chief engineer. He was previously passenger car equipment sales representative in Detroit.

A Finkl & Sons Co, Chicago maker of electric furnace steels, die blocks and forgings, has elected **Arthur Carlson** vice president, production. Formerly assistant production manager, he succeeds **Aubrey Lane** who has retired.

Magnetic Holding Practical on Lathes . . .

focused flux from ceramic magnets mean maximum power

The new Walker Permanent Magnetic Ceramax Rotary Chuck designed especially for lathe as well as grinding applications has one unique advantage over other types of magnetic chucks — it actually prevents magnetization of the machine, the tools and the work — the work piece and tool remain chip free. In addition — powerful permanent Ceramic magnets, providing positive holding with three times the coersive force of ordinary alnico magnets, make possible safe, rugged lathe *turning*.

Other features:

- Variable holding for easy work positioning • Rotationally balanced
- All steel work surface • Special "Lock" feature prevents sudden demagnetization while chuck is rotating • No electrical accessories
- Sizes — Diameters 4" x 12"

Hi Power Standard Electric Chucks

Walker Hi-Power Standard Electric Chucks are used with all general grinding, and feature heavy cast steel construction, hi-magnetic efficiency, dimensional stability. These famed chucks have long been recognized as the most dependable in electro-magnetic holding.

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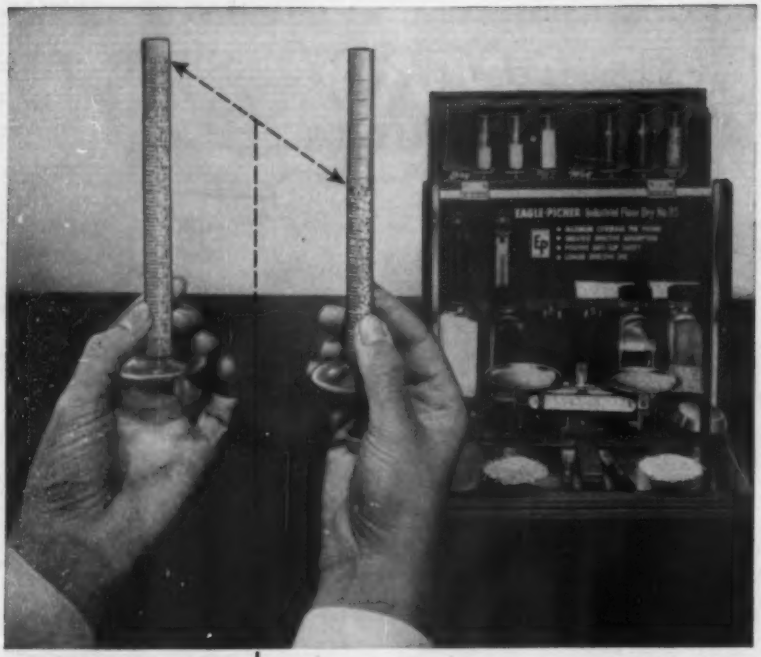

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IN YOUR OWN OFFICE, make this simple 15-minute test. Compare Eagle-Picher Industrial Floor-Dry to any other floor absorbent.

HERE'S WHAT YOU'LL PROVE TO YOURSELF about safe, skid-proof Eagle-Picher Floor-Dry: It's extremely insoluble, absorbs more oil and water. It goes further, provides much greater coverage. It reflects more light, brightens the work area. It's non-combustible, has no chemical reaction. It lasts longer, saves you money!

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WRITE TODAY. Our Eagle-Picher representative will bring the portable laboratory to your office where you may make this test yourself. The Eagle-Picher Company, Dept. AM-613, Cincinnati 1, O.

NEW BOOKS . . .

CENTRIFUGAL PUMP APPLICATION MANUAL—*Published by Buffalo Pumps Division of Buffalo Forge Co, Dept 4, 490 Broadway, Buffalo, NY. 227 pages. Price $5.*

Handbook is designed "to acquaint users of pumps with the general forms and types of centrifugal pumping equipment and to aid them in understanding pump operation and intelligent selection."

Starting with the basic principles of operation, the manual goes on to cover the many factors involved in handling a broad range of liquids under widely differing conditions. Such considerations as viscosity effects, cavitation and suction lift, temperature rise in pumps, packing and seals, installation and trouble shooting are discussed and pictured. Book contains more than 50 illustrations, charts, and tables in addition to reprints of the Centrifugal Pump and Data Sections of the Standards of the Hydraulic Institute as reference.

EVALUATION OF PROTECTIVE COATINGS FOR MOLYBDENUM NOZZLE GUIDE VANES. *By 1st Lieut J R Giancola, USAF. Published by OTS, US Dep't of Commerce, Washington 25, DC, as Report PB 151912. 47 pages. Price $1.25.*

To evaluate the protective effect of various coatings against the effects of jet engine operating conditions, 37 molybdenum guide vanes were subjected to an engine exhaust stream at from 1860 to 1890 F for four hr. Nondestructive and metallographic examinations revealed degrees of deterioration for each type of coating. Results indicate that, within the temperature range of the tests, multilayer electrodeposited metallic coatings have the longest service life. HEL

Half a minute to eight . . . I told the wife I was early.

The American Brass Company
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Please send me a copy of your 8-page booklet which details properties of your four free-cutting, high-conductivity coppers, and suggested machining practices.

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4 ways to cut the cost of high-conductivity parts

There are now four free-cutting, high-conductivity Anaconda coppers that broaden the combinations of mechanical, physical, and fabricating properties available for boosting production and cutting costs of high-conductivity parts. They are furnished chiefly in rod and bar, but are available also as extruded shapes and, except for the leaded coppers, die-pressed forgings of simple design. All have good cold-working properties.

Leaded Copper-126 and Deoxidized Leaded Copper-129 have slightly higher electrical conductivity—98% IACS annealed, 95% IACS, minimum. The difference between them is that Alloy 129, being deoxidized, is not subject to hydrogen embrittlement when annealed or furnace-brazed in reducing atmospheres. Neither leaded alloy is recommended for hot working.

Tellurium Copper-127 and OFHC Sulfur Copper have an electrical conductivity rating of 95% IACS annealed, 90% minimum. Both may be extensively hot worked and neither is subject to hydrogen embrittlement. Tellurium Copper-127 has the advantage of retaining its mechanical properties at temperatures higher than those tolerated by the other free-cutting coppers—and hence is widely used in the welding and cutting-tip field.

The free-cutting coppers may be machined at cutting speeds approaching those used for machining Free-Cutting Brass. For Tellurium Copper-127, however, carbide-tipped tools are recommended as the inherent copper telluride particles cause somewhat greater tool wear.

6847

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FREE-CUTTING HIGH-CONDUCTIVITY COPPER PRODUCTS

Made by The American Brass Company

- FITS PRACTICALLY EVERYONE
- WIDE RANGE OF VISION
- EXCEEDS GOVERNMENT SPECS

Solve protection and fitting problems with the New AO Coverglas Goggle

For the worker who needs impact protection over his regular glasses, this AO Coverglas Goggle (AO 325), does a real job. It fits 99% of workers—(we've tested it widely and know). The 50 mm. round lenses simplify inventories because that's the size which is standard in all other cup goggles used regularly. The frames of black cellulose acetate are better looking than those on previous models. You'll find that the perforated aluminum side shields step up ventilation considerably and they will not corrode. Standard bridge is leather and adjustable. Also available with rigid bar bridge as 325B and with adjustable rigid bridge as 325R. For welders model of this goggle ask for No. 329.

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SAFETY PRODUCTS DIVISION
Southbridge, Massachusetts
Safety Service Centers in Principal Cities

Welcome Your Plant Visitors Thoughtfully with NEW VISITATION Safety Glasses!

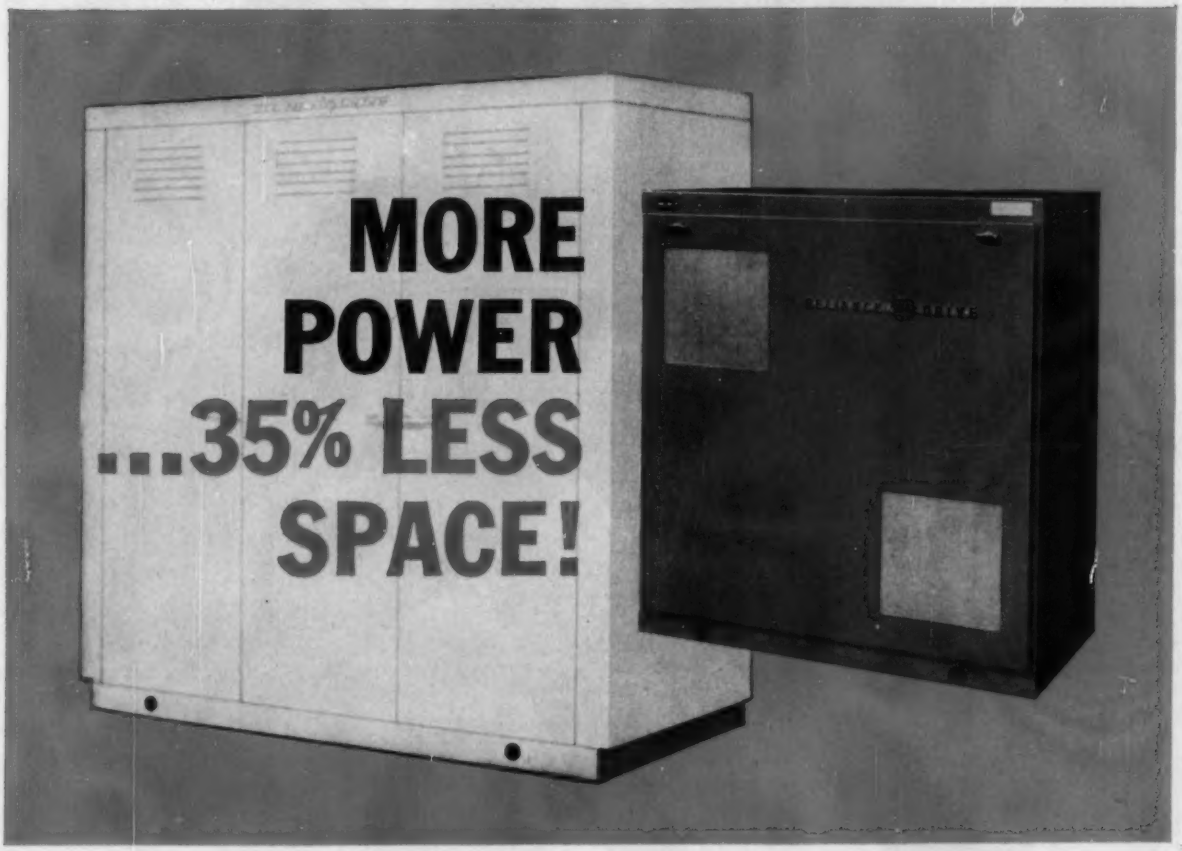
Eye accidents to plant visitors can be costly — and embarrassing. This new face formed spectacle (F790) for temporary and light exposures offers visitors comfortable, lightweight, optically correct eye protection. And the cost is very low — this is the thriftiest priced goggle in the entire American Optical line. Fits over personal glasses. Lens is .020" thick acetate — clear or green. Temples are clear crystal spatula types. Hand your visitors the F790 in the scratch-free cellophane envelope. It's good public relations — and good business!

NOTE: Packaged in bulk in any quantity.

Always insist on Ⓐ Trademarked Safety Products

Your Surest Protection...AO SURE-GUARD Products

Reliance Super 'T' V★S Drives



Both of these control units are rated at 50 horsepower! Actually, the new, small Super 'T' V★S cabinet packs more punch!

LIKE the Reliance Super 'T' Drive Motor, new V★S power units utilize Class B insulation, permitting a more compact unit. 100% overloads of one minute duration are accomplished without failure! Advanced design of ventilation keeps control and power units cooler . . . another reason why smaller size is possible. And service life is substantially extended.

Matched system design of drive motor, power unit and controls produces a highly efficient, integrated drive—to give you a wide range of stepless, variable operating speeds from a-c. circuits.

Super 'T' V★S Drives are available for immediate delivery. Check your Reliance salesman for delivery schedules on the full line, 1—350 hp., Bulletin Number D-2506, has been prepared to give you complete information. Write for it. D-1641

Product of the combined resources of Reliance Electric and Engineering Company and its Master and Reeves Divisions

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Duty Master A-c. Motors, Master Gearmotors, Reeves Drives, V★S Drives, Super 'T' D-c. Motors, Generators, Controls and Engineered Drive Systems.

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CUTTING TOOLS made from HIGH SPEED STEELS *are Better Than Ever*

Today's high speed steel tools for broaching, sawing, tapping, drilling, milling, reaming and other metal cutting operations are better than ever. Through research and development, and new and better production methods, American toolmakers are constantly improving high speed steel tools to help you make better products . . . at less cost.

As a leading producer of high speed and other specialty steels, Universal-Cyclops continues to aid your toolmaker's efforts with its own aggressive research and development program.

Look to your American toolmaker for the finest in high speed steel cutting tools!

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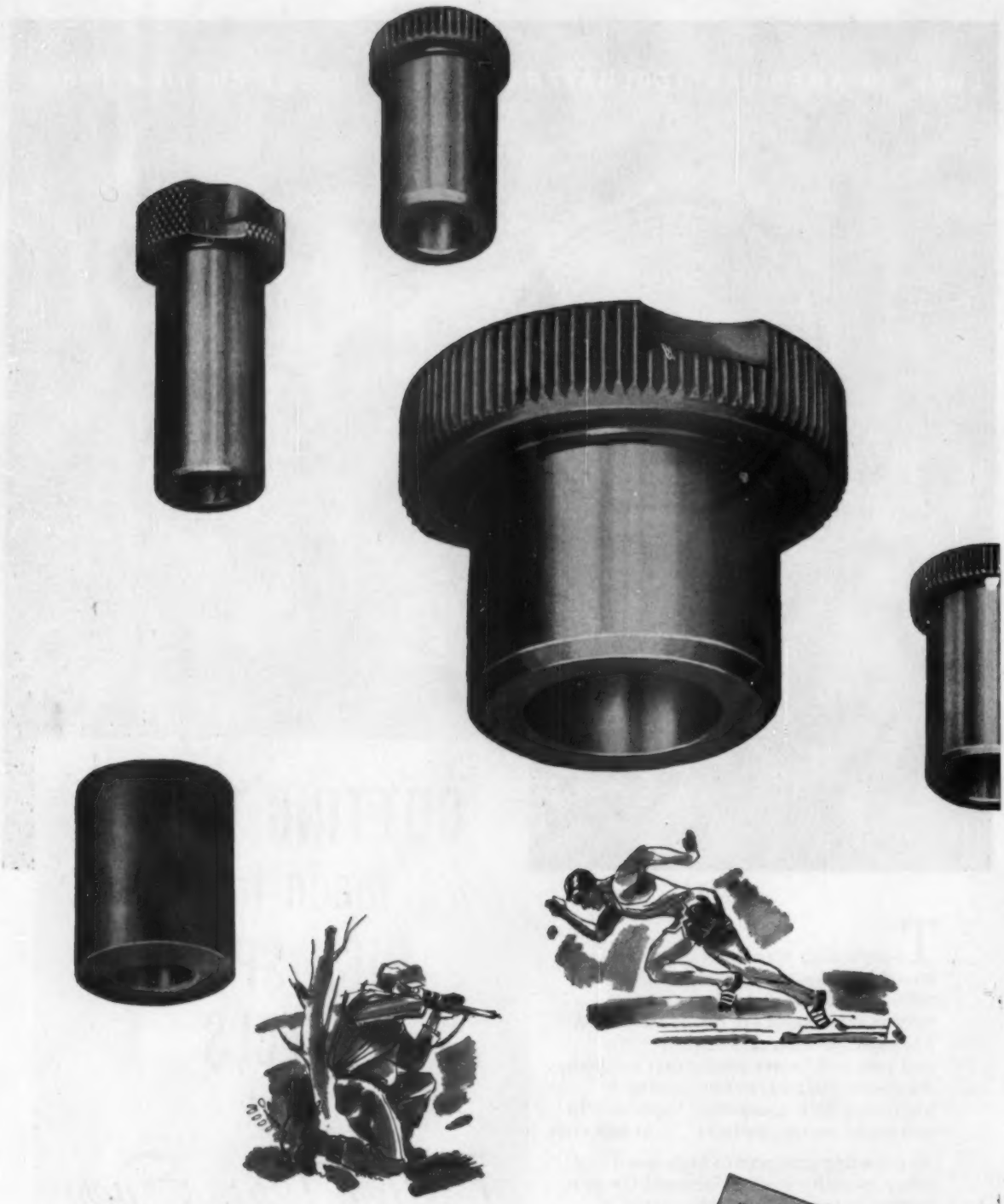

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Why Cleaner, Brighter LUSTERIZED® Bars Handle Easier and Work Better

If you haven't made a comparison run against ordinary cold finished steel bars with clear, bright Bliss & Laughlin Lusterized Finish bars, you will be impressed with the difference.

Lusterized bars start out cleaner, are less messy to handle, remain clean and bright during storage and production. The absence of processing grit, oil and lime keeps chucking mechanisms on automatics free from clogging and production flowing steadily at a profitable pace. The bright, clean surface often requires no finishing operation, reduces the need for elaborate pre-plating preparation.

Lusterized Finish is a Bliss & Laughlin exclusive. It is another result of a constant research program over nearly 70 years to produce cold finished steel bars that will improve your production and profits. Ask for a new folder detailing the production advantages of specifying Bliss & Laughlin Lusterized bars.

LUSTERIZED FINISH is the STANDARD FINISH at Bliss & Laughlin

Specialists in Finish, Accuracy, Straightness, Strength and Machinability

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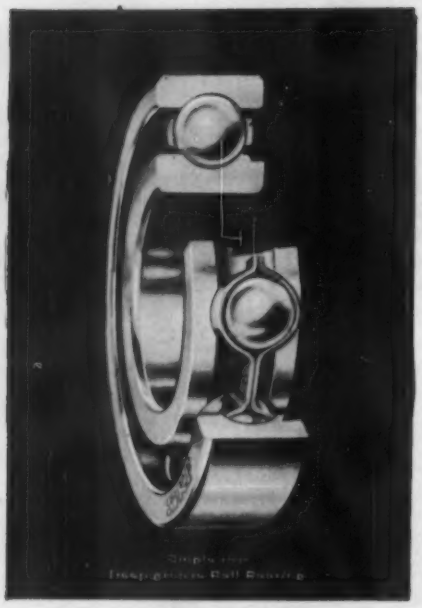
CIRCLE 343 READER SERVICE CARD



Can a standard bearing offer you "more bearing" for your money?

It can if it's made by SKF—because all SKF bearings, both ball and roller, offer special qualities at "production" bearing prices.

Take the single-row deep-groove ball bearing featured here, as an example. SKF designs and builds this type to sustain heavy radial load and thrust load in either direction. Furthermore, it is engineered to run smoothly and quietly at normal speeds with grease lubrication—and at high speeds with oil.

Yet this is a standard SKF ball bearing, mass-produced by automated production equipment at our plant at Altoona, Pa. You can quickly get this bearing in over 100 sizes, ranging from ⅝" to 15.748" O.D., and in a variety of seal, shield and snap-ring combinations.

But why not find out what SKF offers in bearing quality, availability and economy? Just call the SKF branch office nearest you.

4001

Spherical, Cylindrical, Ball, Tyson Tapered and REED Miniature Bearings
EVERY TYPE—EVERY USE
SKF
SKF INDUSTRIES, INC. PHILADELPHIA 32, PA

here's the one SOLUBLE CUTTING LUBRICANT that WON'T GO RANCID

and it's backed by an UNQUALIFIED GUARANTEE

We absolutely GUARANTEE that MACCO 472 MPA will not turn rancid under any circumstances. We are the only manufacturer of soluble cutting lubricants who can make this Guarantee.

IT'S MACCO 472 MPA*

Ideal for MACHINING ALL METALS ON ALL TYPES OF EQUIPMENT

THERE'S NOTHING ELSE LIKE IT!

Hard to believe? You bet! But, it's a fact—backed by experience. One plant with hundreds of machines down 70 days, another 116 days, still another for 6 months (names will be furnished on request) —all started up with the same MACCO 472 MPA solution that was in use when they shut down, and ABSOLUTELY NO TRACE OF RANCIDITY IN ANY MACHINE!

With vacation shutdowns coming now is the time to make the change to MACCO 472 MPA. Save yourself a lot of headaches, and some hard earned maintenance dollars to boot. Write or Phone Today for a Macco engineer. He'll give you facts, and make it possible for you to prove for yourself why MACCO 472 MPA is today's No. 1 soluble cutting lubricant in plant after plant. When vacation is over you'll start up with no worry . . . NO RANCIDITY!

And, in addition, **WE GUARANTEE TO INCREASE YOUR TOOL LIFE 25%, or more!**

***An Exclusive Development**

472 MPA is one more of many reasons why

THE METALWORKING INDUSTRY LOOKS TO MACCO FOR LEADERSHIP

MACCO
PRODUCTS COMPANY

9202 S. SANGAMON ST., CHICAGO 20, ILLINOIS
PRESCOTT 9-0800

CIRCLE 345 READER SERVICE CARD

What did this failure cost?

LOOK TO INGERSOLL FOR THE ANSWER

Probably a lot more than should have been gambled! Misapply a cutter, or fail to match it to the machine, and costly failure can be predicted as a certainty.

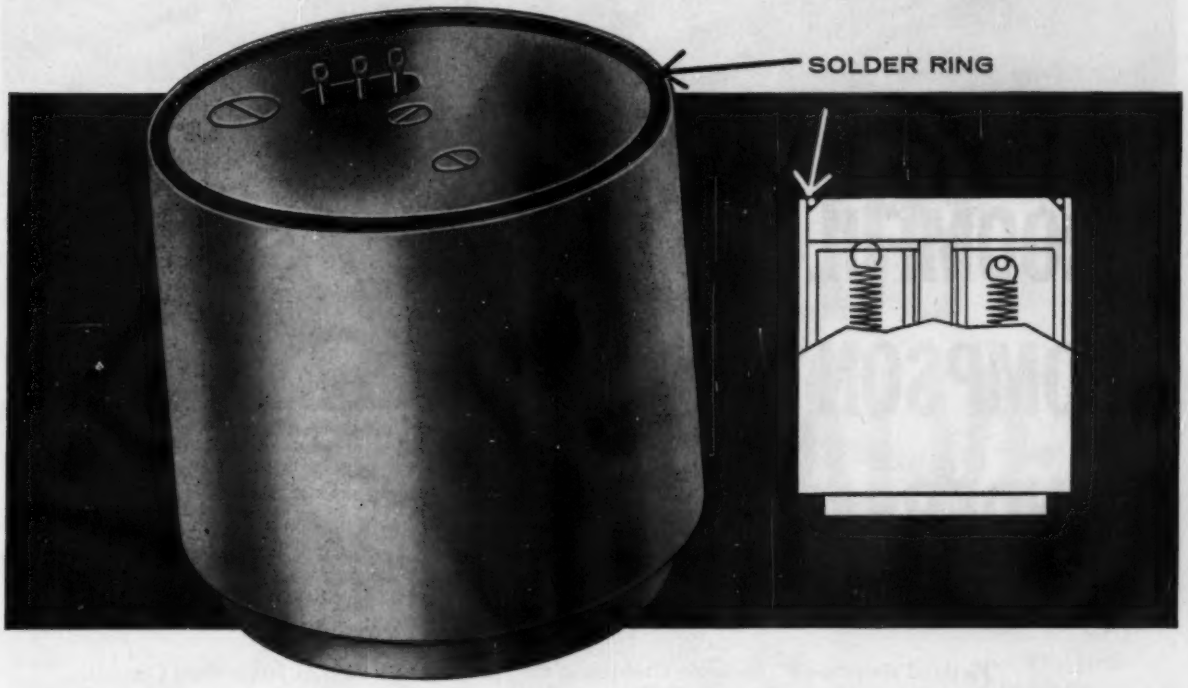
Only when metal removal programs are carefully analyzed in advance can cutter misapplications be assuredly avoided. That's why many firms rely on Ingersoll for help in arriving at the economical answers to their cutter selection and application questions.

Costs reduction is planned before, not after the work is done. Why not let an Ingersoll representative make a preliminary survey of your upcoming metal removal jobs? It will cost you nothing . . . could lead to important savings. Ask a representative to call, or write for the booklet, "Ways to Reduce the Cost of Chips." Address Dept. K-68.

THE **INGERSOLL**
MILLING MACHINE COMPANY **CUTTER DIVISION** ROCKFORD, ILLINOIS

Precision soldering 7 Times Faster...

with TOCCO Induction Heating*



When G. M. Giannini and Co., Inc., Pasadena, California, switched from old-fashioned methods to TOCCO Induction Heating they increased production of these high-precision accelerometers from 4 to 30 per hour—with a commensurate *decrease* in production costs.

Here's what a Giannini official has to say about the TOCCO installation: "Prior to using TOCCO for this purpose, we had tried soldering irons, normal torches, resistance sealing, and even threaded screw fittings, with uniformly poor results. Essentially, the TOCCO unit has permitted us to build, in production quantities, oil-filled hermetically sealed units that could not be produced in any other way."

Whether your production bottleneck involves soldering, brazing, heat treating or heating for forming it pays you to investigate TOCCO as an economical way to do it better, faster and at lower cost.

THE OHIO CRANKSHAFT COMPANY

Mail Coupon Today—NEW FREE Bulletin

The Ohio Crankshaft Co. • Dept. B-6, Cleveland 5, Ohio
Please send copy of "Typical Results of TOCCO Induction Brazing and Soldering".

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A ROOMFUL of THOMPSON GRINDERS

This is the eighth Thompson grinder recently installed at Jessop which grinds plates and sheets up to 60" × 96" in size.

Jessop precision ground flat stock which is used in gages, dies, verniers and other exacting products.

Pictured above are 4 Thompson Grinders in the Specialties Division of Jessop Steel Company, Washington, Pennsylvania. There are 4 more Thompsons which are not shown in the above photo. All these Thompson machines are grinding to the extremely accurate tolerances and fine RMS finishes that distinguish Jessop's precision ground flat stock.

There are excellent reasons for using 8 Thompsons on this essential production. Mr. Joseph Manfredi, who is responsible for the quality and production of this famous ground flat stock, says, **"We have recently installed our eighth Thompson grinder in this division. We have proven the top performance of these rugged machines for many years. They give us the extreme accuracy and precision we demand—day after day with a minimum of maintenance."**

You may not need 8 Thompson grinders in your operations but it will pay you well to investigate what just one Thompson machine can do toward saving time, improving your products and cutting your costs of manufacture.

Your inquiries are invited.

MMT·PE

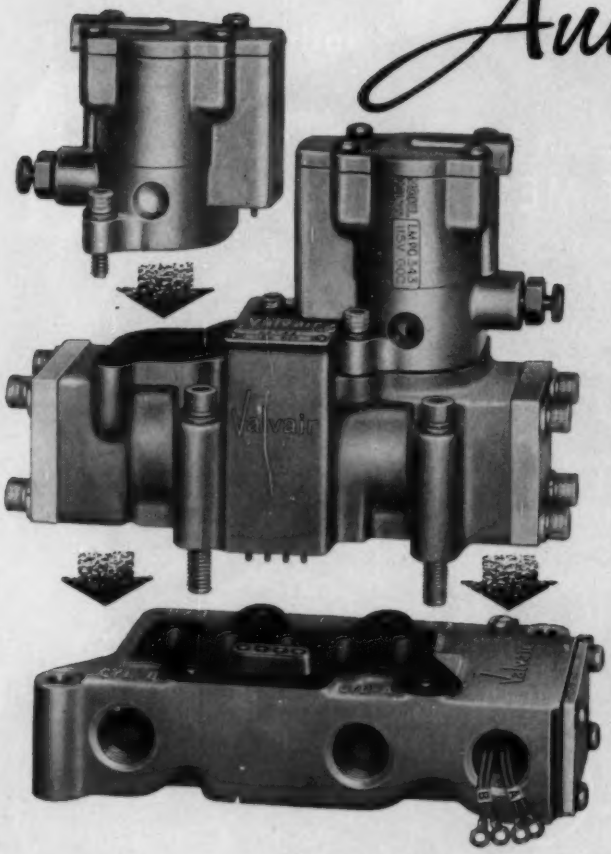
THE THOMPSON GRINDER CO.
SPRINGFIELD, OHIO

"Keep Thompson in mind for that daily grind"

SURFACE GRINDERS

Announcing

VALVAIR® ½" NPT PLUG-IN VALVES



MODEL PD-441 shown. 4-way single or double pilot-operated types, for sub-base or manifold mounting. Aluminum and stainless steel components assure multi-mill on cycle dependability. Interchangeable pilots, with coils guaranteed against burn-out for life of valve, fit any plug-in Speed King. Coils for ac or dc, any voltage . . . 35 — 200 psi range . . . integral junction box . . . optional manual over-ride, common or separate exhaust ports, sub-base connected external pilot supply . . . ¾ in. exhaust ports, ½ or ¾ in. inlet and cylinder ports . . . valve meets JIC standards.

Based on the service-proved design principle of the Speed King ¼ in. plug-in Valvair's ½ - ¾ in. plug-in valve series provides plug-in convenience and versatility to a wider range of control valve applications.

Electrical and pneumatic circuits are completed automatically when valve and pilot are plugged in . . . bolted down. The result — cost-cutting reduction of original installation and maintenance time. All power connections are made permanently in sub-base or manifold . . . there's no need to disturb piping or wiring for quick in-service maintenance.

What's more, advanced design shortens stroke . . . speeds response. Separate coded (4-wire) circuits on double solenoid models meet JIC requirements. Flow area through valve and sub-base equals that of full ½ in. pipe.

Whether your control valve applications are on the drawing board or now in service, it'll pay you to investigate the advantages of Valvair plug-in design. A call to your near-by Valvair field office will bring prompt application engineering recommendations.

For more information, write for Bulletin SPL. Address Dept. AM-660, Valvair Corporation, 454 Morgan Ave., Akron 11, Ohio

Valvair AKRON 11, OHIO

Other INDUSTRIAL DIVISIONS of IBEC: The Sinclair-Collins Valve Co. The Bellows Co., Akron, Ohio • V. D. Anderson Co., Cleveland, Ohio.

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Milford Rivet & Machine Company reports . . .

Precision Parts Ground
20 TIMES FASTER
when put on the No. 18 Blanchard
"408 precision washers, in one chuck load, now surface ground in same time as 20 by former method . . . substantial savings on all other Blanchard-ground jobs . . . finished work quality outstanding . . . former sub-contracted jobs now done at less cost in our own shop . . . operator fatigue practically eliminated . . . maintenance is very low."
Are you missing opportunities like these by not using Blanchards on your surface grinding jobs? Write for your copy of "Work Done on the Blanchard"
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BLANCHARD
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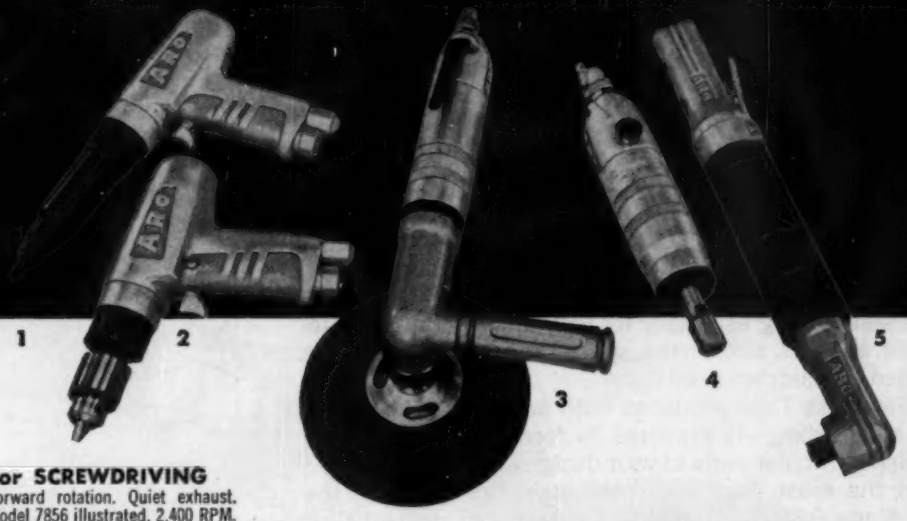
Another New **ARO** Air Motor Produces

SUPER POWER

...brings you

SUPER PERFORMANCE *in new* ARO "2200 Series" TOOLS!



1 For SCREWDRIVING
Forward rotation. Quiet exhaust. Model 7856 illustrated, 2,400 RPM. Adjustable clutch.

2 For DRILLING
Big power in compact size! Quiet exhaust. Model 7846 illustrated, 2,400 RPM.

3 For SANDING
Right-angle sander. Quiet exhaust. Model 7944 illustrated, 3,500 RPM. Polishers also available.

4 For GRINDING
Short grinder, aluminum housing. Quiet exhaust. Model 7872 illustrated, 18,000 RPM.

5 For NUTSETTING
Heavy-Duty, Right-Angle. Direct Drive. Model 7825 illustrated, 800 RPM.

Mighty—and eager to prove it! This great new series of ARO super-powered tools gives you more brute power per pound! More speed to slash costs on a wide range of assembly jobs. Greater safety, too—no shock or spark hazard.

Every tool is precision-built, and is more easily adaptable to your specific application. Your ARO Distributor invites you to job-test these new cost-saving tools *now* without obligation!

ARO

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Also Air Hoists . . . Automation Tools
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OSTUCO tubing is the exact tubing you need for your product because OSTUCO Tubing is CUSTOM MADE for your product. Your order is manufactured to your own specifications to produce steel tubing especially for your application—the precise grade, analysis, size, shape, special anneal and tolerances best suited to your own needs.

Ohio Seamless Tube produces both seamless and electric welded steel tubing—is prepared to form many finished or semi-finished tubular parts to your designs.

To get the most from your next steel tubing order, use Custom Made OSTUCO TUBING. Contact your nearest Ohio Seamless representative, or send part drawings to the plant at Shelby, Ohio—Birthplace of the Seamless Steel Tube Industry in America.

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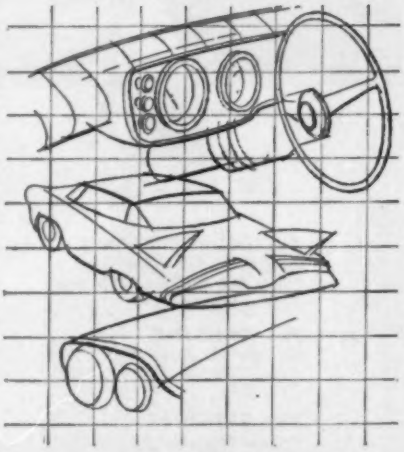

Model illustrated built to 3.5 mm scale.

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OHIO SEAMLESS TUBE

Division of Copperweld Steel Company • SHELBY, OHIO

Seamless and Electric Resistance Welded Steel Tubing • Fabricating and Forging

300 HOUSINGS PER HOUR

produced on Greenlee machine— with assist from VICKERS hydraulics

Here's a Greenlee transfer machine that produces 300 steering gear housings per hour while performing a total of 114 close tolerance machining operations. This outstanding performance record is achieved because the machine combines advanced design ideas with the best available components.

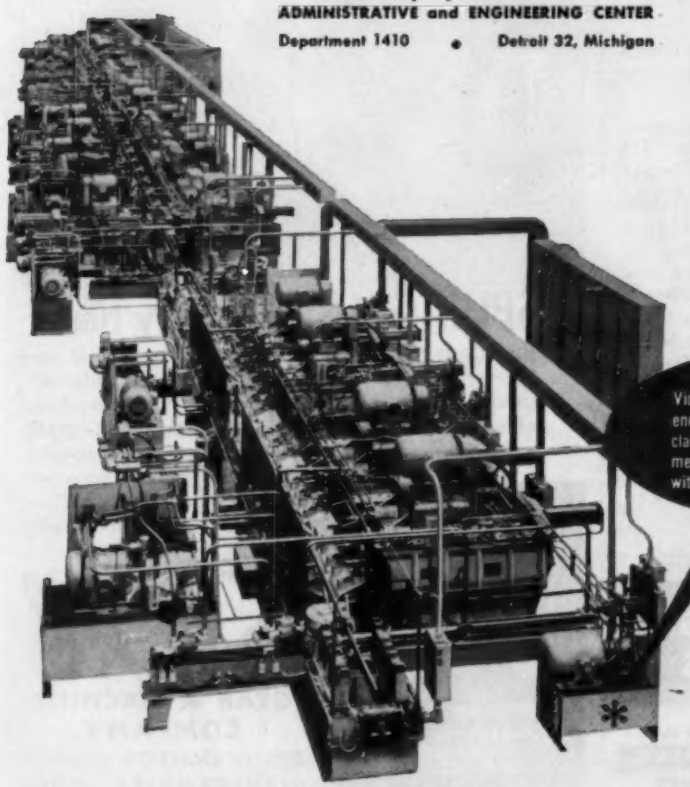
Self-contained Vickers hydraulic power packages provide controlled power for clamping the pallet-mounted workpieces in precise position at each work station, driving transfer mechanisms and for movement of certain machine heads. These power packages are designed to JIC (Joint Industry Conference) standards which means easy maintenance and minimum downtime to you.

Vickers offers you power packages, either standard or custom engineered that provide an almost unlimited number of choices to meet your specific technical requirements. You can choose from the broadest product line in the industry any combination of controls for use with single, double, two-pressure or two-stage pumps (the latter for pressures to 2000 psi), and for variable and constant delivery pumps to 5000 psi. Your choice of components will be packaged with the size or shape reservoir best suited for your job.

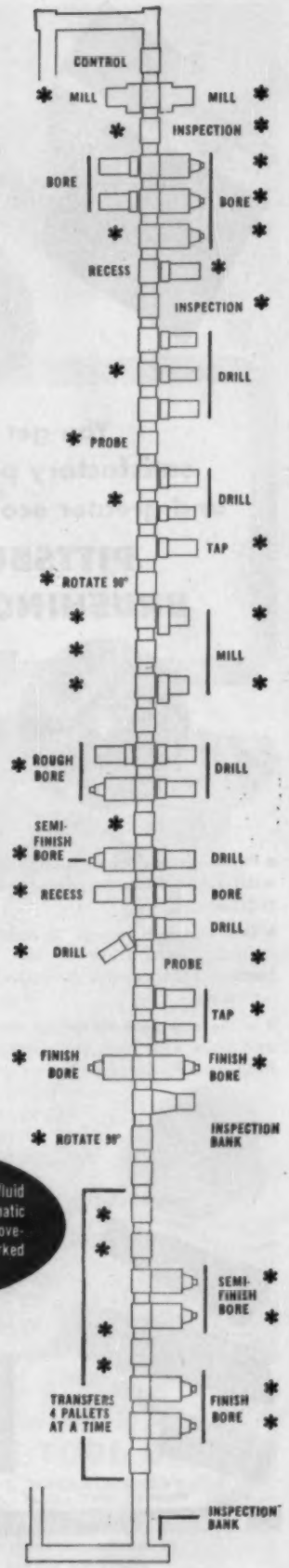
Whether the Vickers power package you choose is standard or custom engineered, you save money and time because it comes *ready-to-go*—designed and assembled to the highest standard of quality by hydraulic specialists.

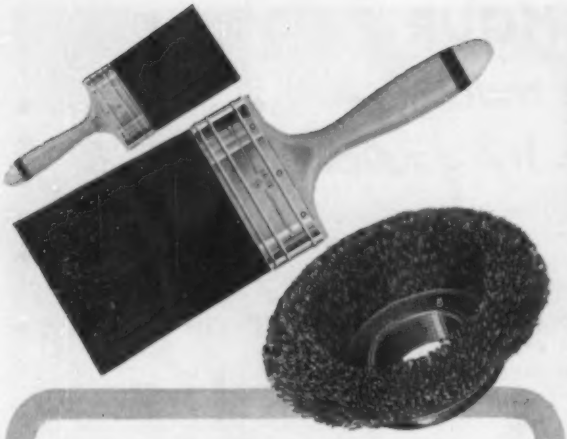
Get more data by writing today for Bulletin 5001C or by consulting your nearby Vickers application engineer.

VICKERS INCORPORATED 8514
DIVISION OF SPERRY RAND CORPORATION
Machinery Hydraulics Division
ADMINISTRATIVE and ENGINEERING CENTER
Department 1410 • Detroit 32, Michigan



Vickers power packages supply fluid energy for fast, precise, automatic clamping, transfer and head movement at station locations marked with asterisk.





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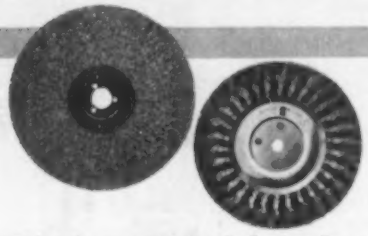
PITTSBURGH BRUSHING TOOLS



- **Pittsburgh has been supplying** industry for many years with quality brushes designed to meet specific finishing requirements.
- **They're tough enough** to resist abrasion. Carefully controlled distribution of the brushing stock provides perfect balance and gives top efficiency with enduring economy.
- **In the complete Pittsburgh line** are brushes of all types and sizes. Our long experience in designing and making high-quality brushes for every need can save you time and money. Write or call Pittsburgh Plate Glass Company, Brush Division, Dept. AM-60, 3221 Frederick Avenue, Baltimore 29, Maryland.

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PITTSBURGH PLATE GLASS COMPANY

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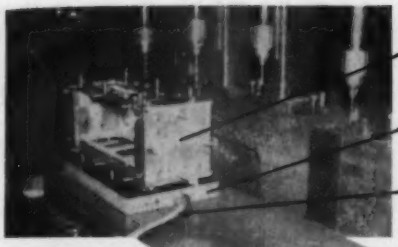
CIRCLE 354 READER SERVICE CARD



HAVE YOU A PRODUCTION SPEED-UP PROBLEM?

A Union Jato Airborne Fixture Table can solve it with ease!

With a thumb and forefinger an operator can accurately position heavy work pieces while using the other hand to actuate the machine. A single rectangular 8" x 18" table such as used in photo above floats 2,880 lbs. For complete information on other types and special applications write to...

Rotary table 59" dia. floats 50,000 lbs.

UNION MANUFACTURING DIVISION
UNION MANUFACTURING COMPANY
CHURCH ST., NEW BRITAIN, CONN.

CIRCLE 355 READER SERVICE CARD

SPUR GEARS for Every Need!

This trio is representative of Stahl's tradition of precision-in-quantity. These steel spur gears have identical specifications—72 T., 2" C.P., and 6" F. Two are fitted with bronze bushings. A 45" Universal Slabbing Mill is their destination. General-purpose or highly specialized, Stahl makes them all, EXACTLY to specification, promptly and economically. Get our estimate.

SPURS TO 72" PD. 1 DP
BEVELS TO 54" PD. 1 DP
SPIRAL, HELICAL and WORM GEARS TO 48" PD. 2 DP
CONTINUOUS TOOTH HERRINGBONE TO 60" PD. 2 DP
SPROCKETS TO 72" PD. 2½" CP
RACKS TO 20 FT. LONG. 3 DP
SILENT GEARS: RAWHIDE, BAKELITE, FIBROIL
HEAT-TREATED CASE OR FLAME HARDENED GEARS— OF CARBON OR ALLOY STEEL

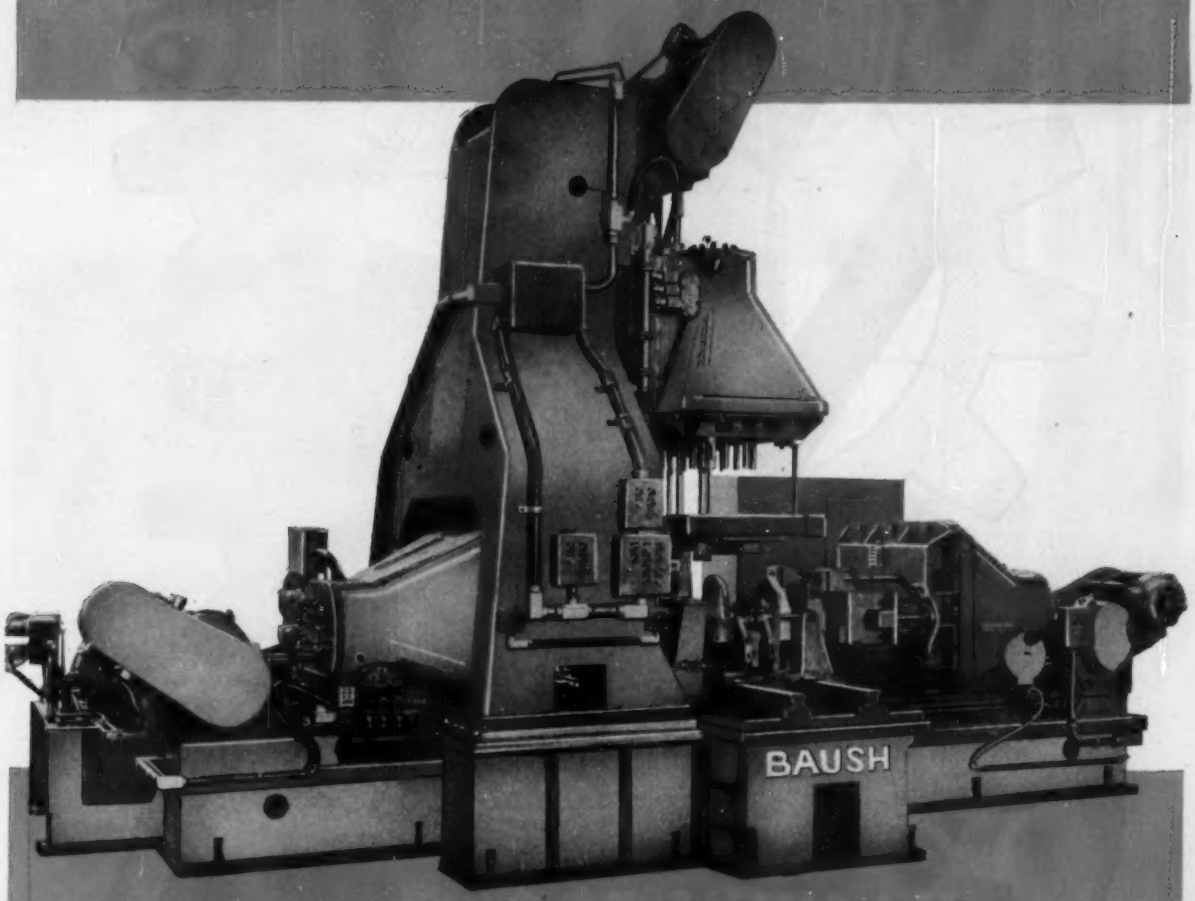
Stahl

GEAR & MACHINE COMPANY
3901 HAMILTON AVENUE
CLEVELAND 14, OHIO

CIRCLE 356 READER SERVICE CARD

SPECIAL 3-WAY "H-15" AUTOMATIC HYDRAULIC

WITH MULTI-SPINDLES FOR DRILLING AND REAMING TRACTOR PARTS



Baush specifically designed this single purpose machine to speed production for a leading tractor manufacturer. This "H-15" is unique in that by changing the hydraulic unit to a recirculating ball screw the machine becomes a 100% mechanical leadscrew machine.

Three 20" x 30" heads are bored and furnished with 24 spindle pinions, and all spindles are arranged for two (2) speeds and a neutral position. The heads have master-bored cluster plates with a total of 35 slip-sleeve spindles for drilling or reaming.

As illustrated, this machine has automatic hydraulic operation of fixture and slide.

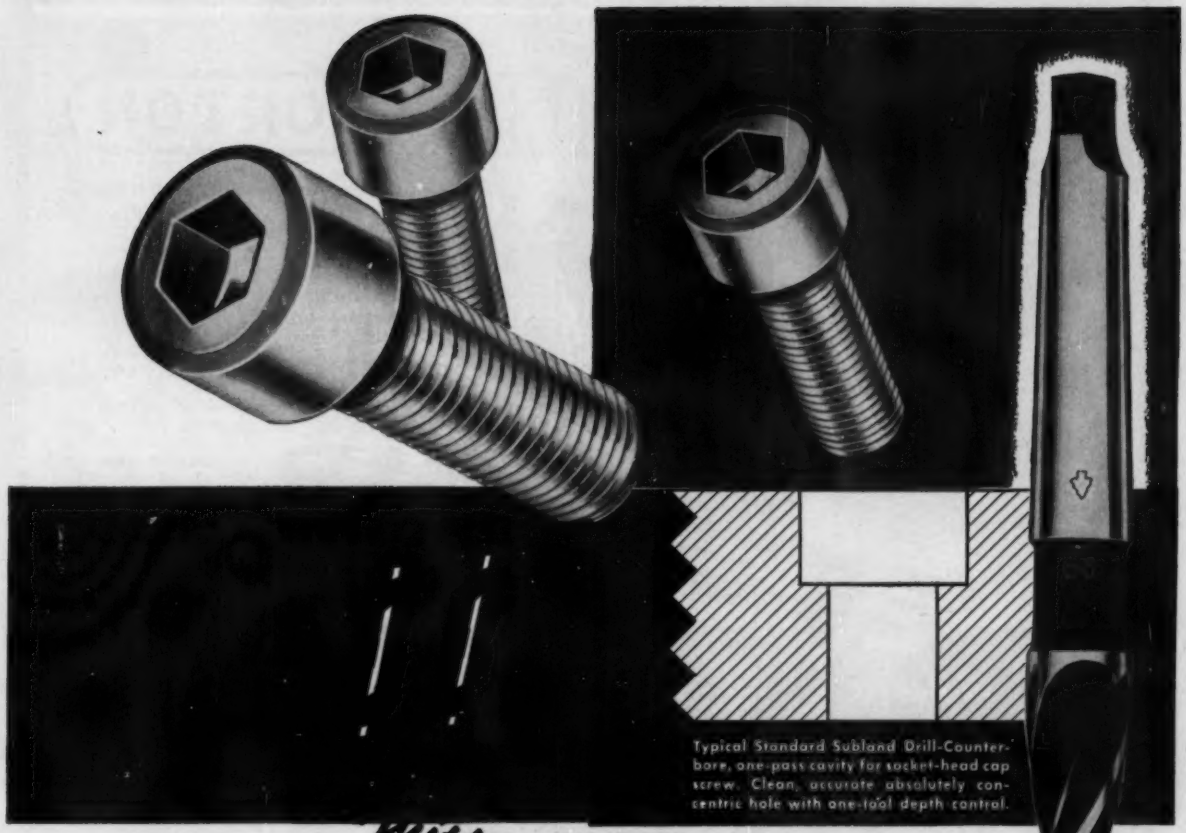
Electrical controls are all J. I. C. Standard, with three (3) of the motors being 15 HP and three (3) 5 HP.

Write for new brochure with complete specifications.

Sections, or all of this type machine are adaptable to working different parts in the future with a minimum of changeover.

BAUSH
MACHINE TOOL CO.
SPRINGFIELD 7, MASSACHUSETTS

INFORMATION:
VEREIN DEUTSCHER WERKZEUGMASCHINENFABRIKEN (VDW)
FRANKFURT (MAIN), Am Hauptbahnhof 6
Telefon: 334570, Telegramm-Adresse: Modul, Telex: 41 2607



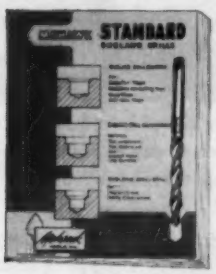
Typical Standard Subland Drill-Counterbore, one-pass cavity for socket-head cap screw. Clean, accurate absolutely concentric hole with one-tool depth control.

...with.. MOHAWK STANDARD SUBLAND DRILLS

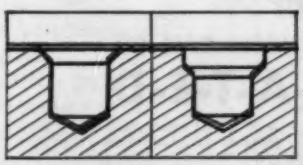
Mohawk Standard Sublands are the modern answer to combination tooling operations that mean greater production savings.

Why stock heavy inventories of expensive drilling tools for consecutive operations when just one-pass with a Mohawk "standard" will do the job... better, more accurately and economically?

If you want fast, one-tool control, positive concentricity, lower hole costs, less scrap, fewer jigs and fixtures and smaller tool inventory . . . you really need Mohawk Standard Sublands. They're available, right now, from local distributor and/or factory stocks in every size, type and combination for fast, off-the-shelf delivery.



Send for your Copy... of the new Mohawk "Standards" Catalog. Lists all practical sizes, types plus easy method of determining your needs ...more economically.



Subland Drill-Chamfer | Subland Drill-Drill

Mohawk also offers a complete range of "Standards" for drilling prior to the simplified use of:

Regular Taps, Fluteless (non-cutting) Taps, Pipe Taps.

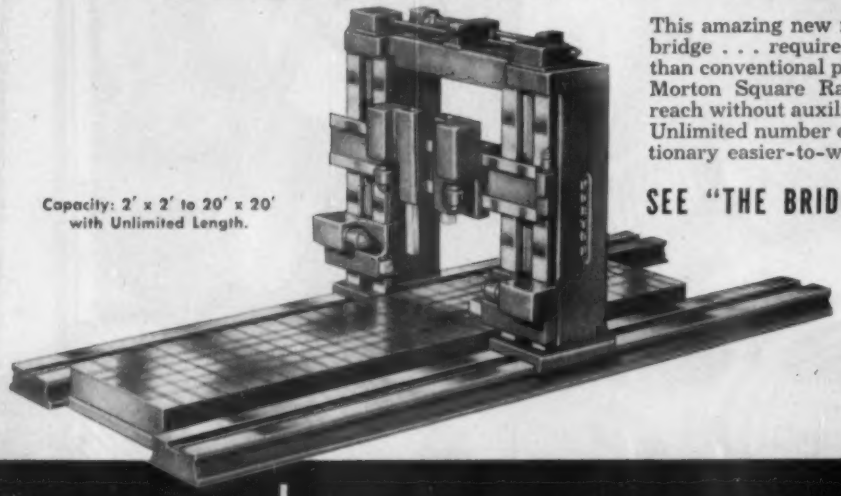
Tap Drill and Body Clearance for Screws and Bolts.

Mohawk TOOLS, Inc.
Montpelier, Ohio

world's largest producer of Sublands

PRESENTING:

THE BRIDGE MILL BY MORTON



Capacity: 2' x 2' to 20' x 20' with Unlimited Length.

This amazing new machine has movable bridge . . . requires 1/3 less floor space than conventional planer mills. Exclusive Morton Square Rams have extended reach without auxiliary bolt-on supports. Unlimited number of work pieces on stationary easier-to-work table.

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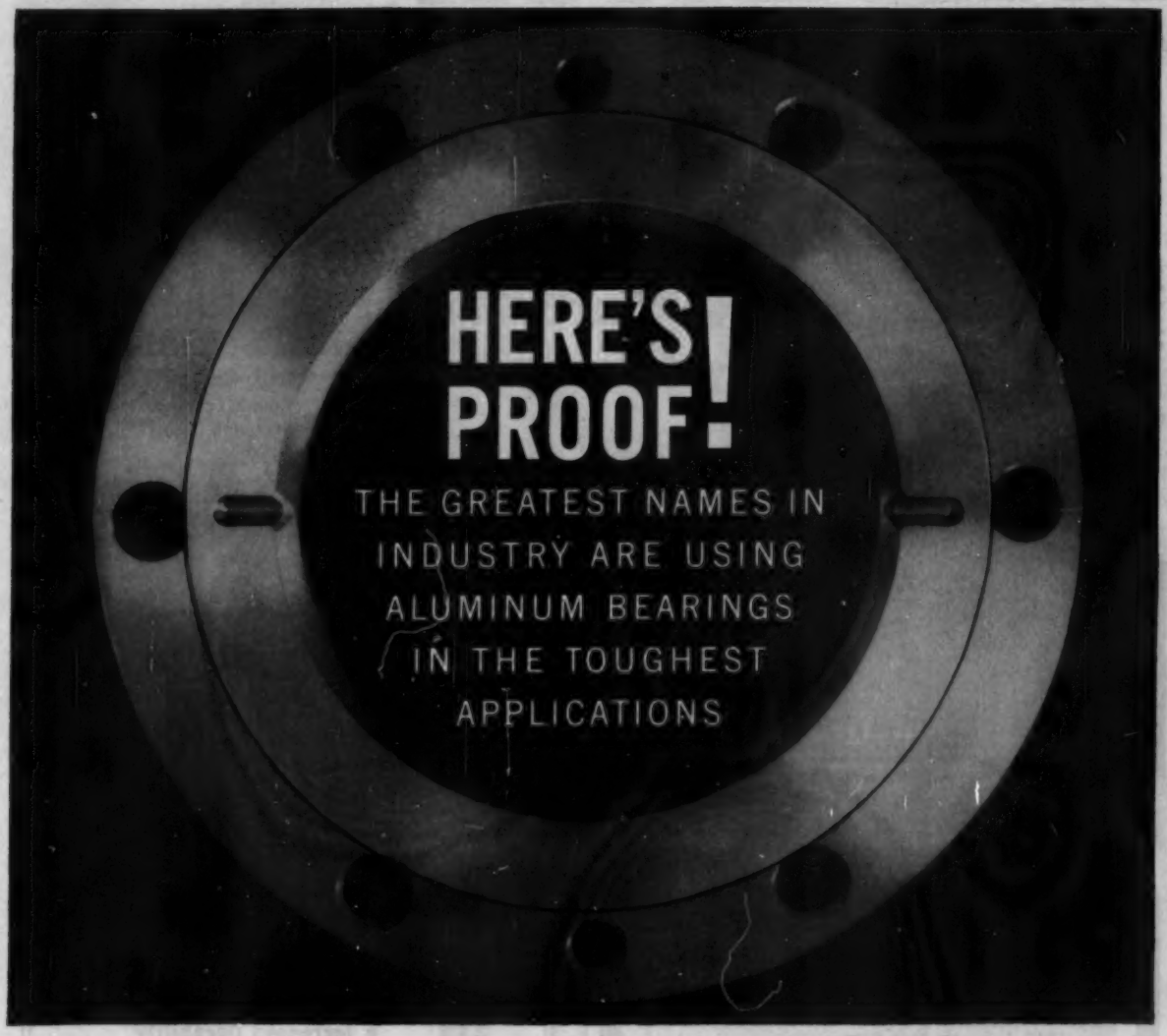

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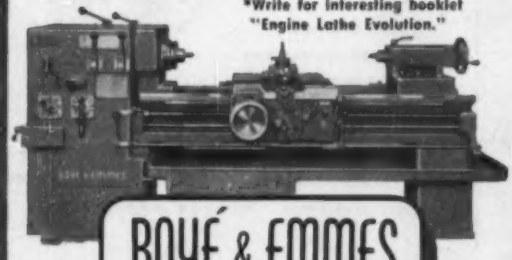

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Small and light enough to hold in one hand, METROsurf is battery powered—ready for immediate use anywhere!

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Today's precision requirements rule out "eye" or "feel" methods of checking surface finish. METRO*surf* makes it more accurate, easier and faster.

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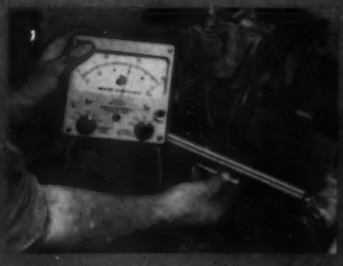

Big dial shows average surface roughness in seconds right at your machine . . . without lifting or removing your work.

Measure any surface however complex—ID, OD, even gear teeth. Reach way into small, nearly inaccessible surfaces or measure across several feet of material on a production line.

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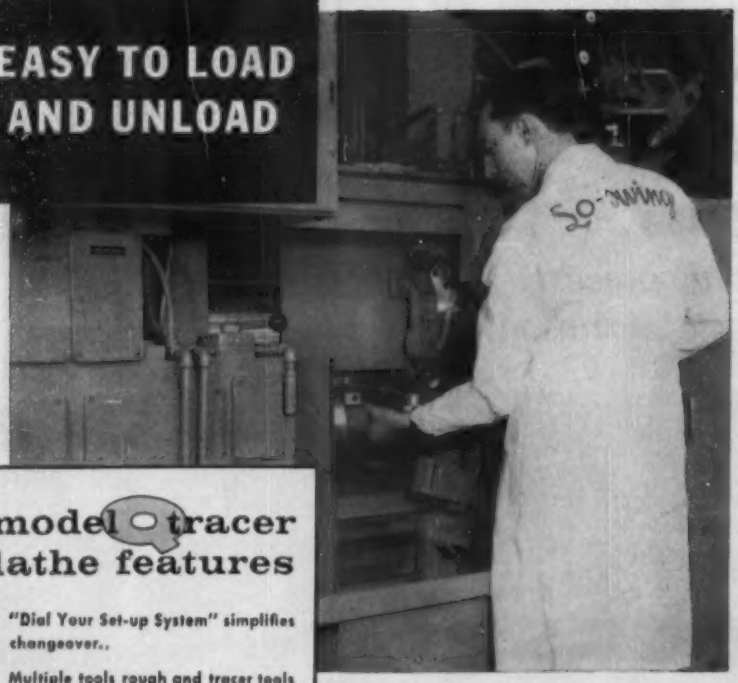

model Q tracer lathe features

- "Dial Your Set-up System" simplifies changeover..
- Multiple tools rough and tracer tools finish turn in one automatic cycle.
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- Templates clear of chip area.
- Easy to load and unload.
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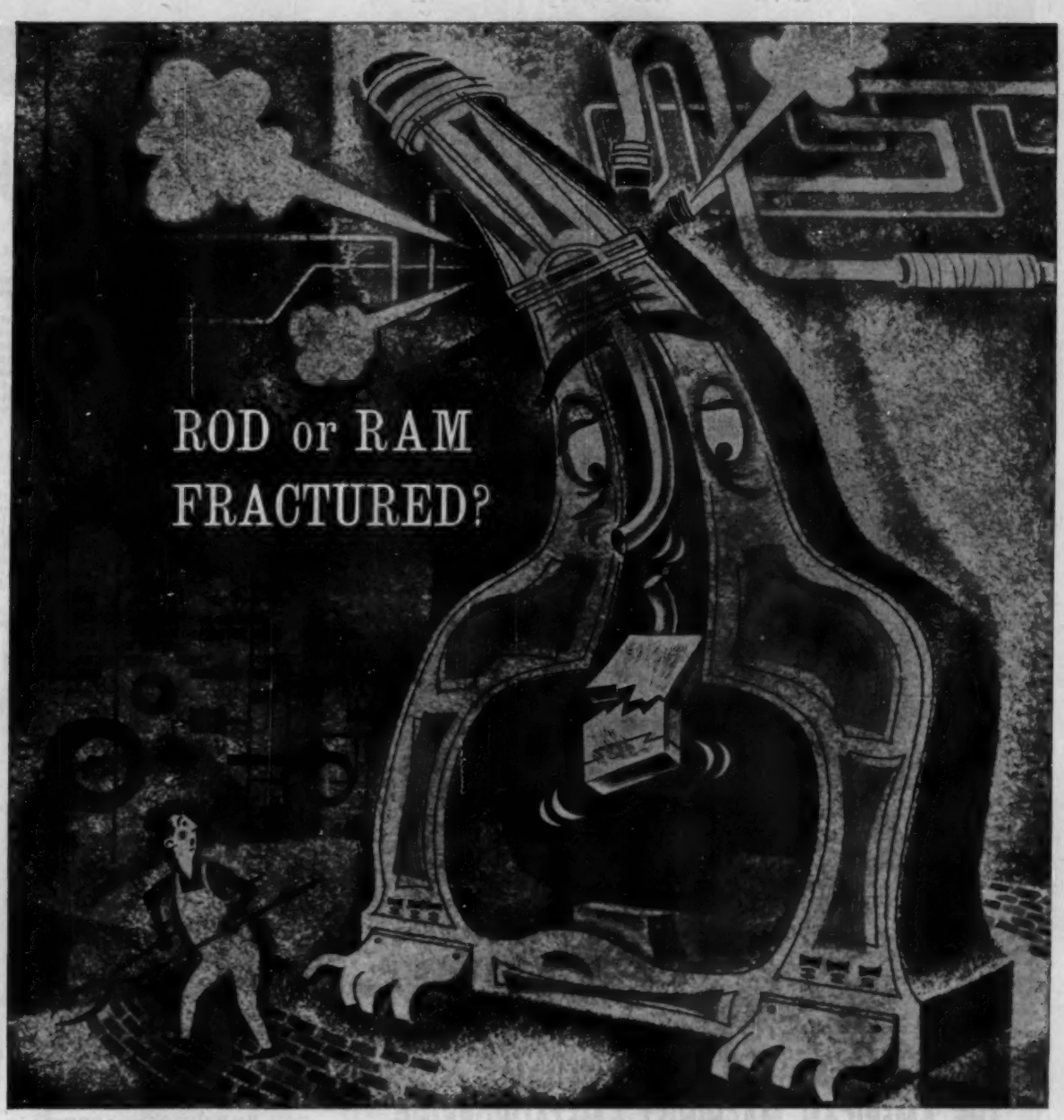

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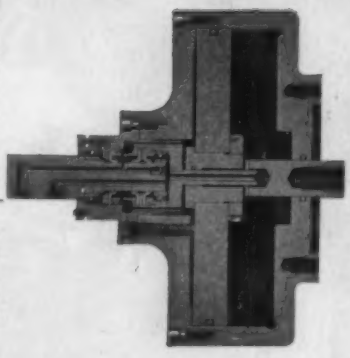

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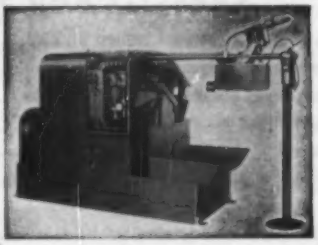

CATALOG

Has complete specifications of all models. Illustrates parts that are being formed, grooved, flanged or chamfered and cut off in a single operation at a high rate of speed. Also describes the automatic feeder, hot spinning machine for sealing ends of tubing, and the Modern Safety Drill Table.

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MODERN MACHINE TOOL CO.

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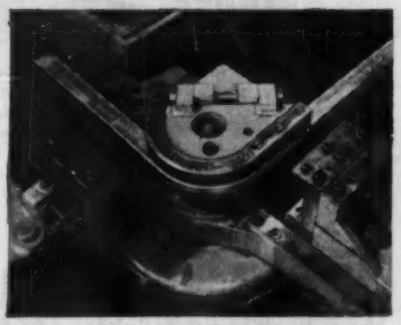

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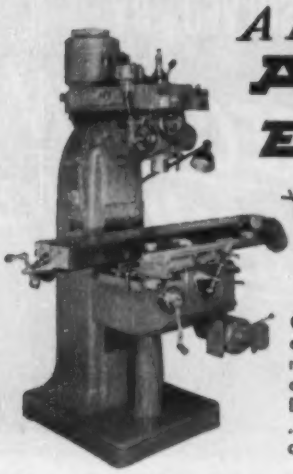

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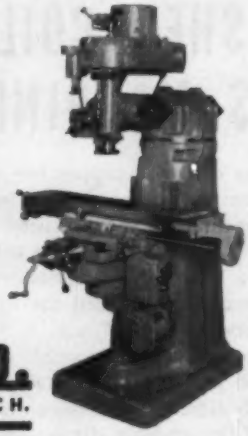

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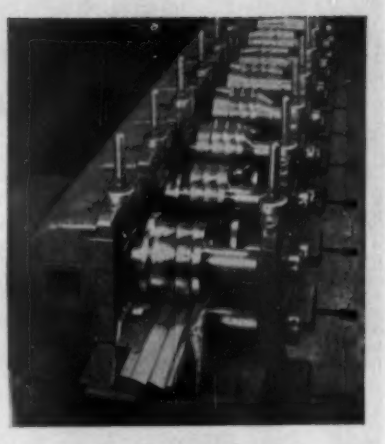

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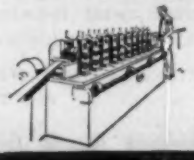
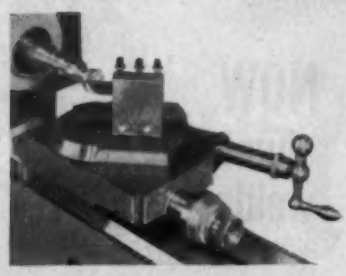
5519 Walworth Avenue • Cleveland 1, Ohio



YODER COLD ROLL FORMING MACHINES

CIRCLE 385 READER SERVICE CARD

SOME OF THE MANY
COST-SAVING FEATURES



RADIUS TURNING ATTACHMENT

Concave and convex surfaces are readily generated after a simple set-up with a direct-reading dial indicator. Worm gear feeding insures a finely controlled finish.

REAR SLIDE CUT-OFF

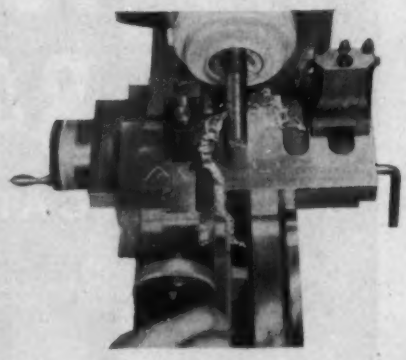
The rear tool station is an added feature to the traditional convenience and accuracy of the Wade Super Slide Rest. A cut-off tool may be left in readiness to avoid tool changing.

Cut toolmaking costs with a Wade *#94 FINISHING LATHE*

Every design feature built into the Wade Finishing Lathe has one aim in view: to make this machine the *most convenient and the fastest to use* for toolmaking and limited production. The Wade Model #94 has a 9″ swing, 1-1/16″ collet capacity and will accept 15″ between centers.

Write for literature.

Sold by Pratt and Whitney Co., Inc. in most areas.



DIRECT READING DIALS

Large satin-chrome dials read directly in thousandths of an inch and are resettable to zero.

THE WADE TOOL CO.
WALTHAM 54, MASS., U. S. A.

MAKERS OF
PRECISION MACHINE TOOLS
FOR AMERICAN INDUSTRY

CIRCLE 386 READER SERVICE CARD 279

NOW aluminum weldments —in close tolerance components!

Since the early days of electronic computers and the adoption of lighter weight ALUMINUM in the manufacture of component frames, precision tolerances required in the development of modern electronic computer devices have posed a serious problem.

Out of the experience of many years of component building for a large manufacturer of business machines and computer devices, Marathon Industries has developed unique methods and equipment for welding ALUMINUM within exceptionally close tolerances.

If you have a weldment problem in ALUMINUM—or with any metal—write or call your nearest Marathon Industries branch, TODAY!

COMPLETE METAL FABRICATION, ELECTRONIC ASSEMBLY

MARATHON INDUSTRIES, INC.
59 Huntington St., Cortland, N. Y., SKyline 6-2866
Lexington, Ky., Phone 5-0020

CIRCLE 387 READER SERVICE CARD

NEW PART UNLOADERS REDUCE HANDLING

For fast, positive and lower-cost blank removal, use Lahr reciprocating chute unloaders actuated by your press stroke. Can be cable-timed (air power on out stroke) or rack-driven through full cycle. Simple mounting plus versatility of unloading to bins and conveyors. Variable stroke with gear change. Write for Brochure and Prices.

Model 20-59 shown

STANDARD MODELS AVAILABLE

Model No.	Tray Width	Tray Stroke	Power In	Power Out
20-RR-59	10" to 36"	10" to 20"	Rack	Rack
20-CT-59	10" to 36"	10" to 30"	Cable	AirCycle
30-RR-59	10" to 72"	12" to 30"	Rack	Rack
30-CT-59	10" to 72"	12" to 30"	Cable	AirCycle

Special tray widths and strokes available

Lahr MACHINE & TOOL CORP.
3406 MAPLEWOOD AVE. — TOLEDO 10, OHIO

CIRCLE 389 READER SERVICE CARD

VALUABLE REFERENCE

free 84-PAGE CATALOG

One Complete Source of Detailed Specifications for Designers, Production Managers, Toolroom Foremen

Hundreds of NEW ITEMS

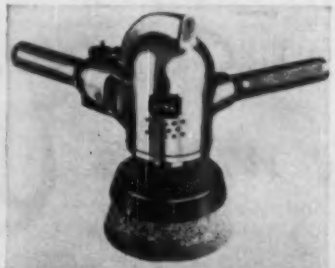
ALL NEW — Complete specifications and cost saving data on over 2000 "Standards", including world's largest line of work-holding equipment, chuck jaw blanks, handles, knobs, wheels, strap clamp assemblies, forged items, plus hundreds of other jig and fixture components. Detailed specifications, engineering drawings. The one complete source for data on all the "standards" for tool, die, jig, and fixture design and application.

Write for your FREE copy today.

JERGENS TOOL SPECIALTY CO.
Dept. AM-6, 712 E. 163rd St., Cleveland 10, Ohio

AIRETOOL GRINDERS AND SANDERS...

for high speed rough and finish grinding



Grind better and faster with job-proven pneumatic grinders by Airetool. For heavy duty work, nothing beats the new Airetool 700-V vertical grinder with revolving guard. Well balanced and easy to handle, it takes a 6" wheel or brush. And, for precision work, feather edge sanding and fine metal finishing, there's Airetool's Model 500-V lightweight vertical sander with flexible pad. Takes up to 7-inch discs with three distinct models operating at 2300, 3000 and 4000 rpm. For information on Airetool's complete line, write for Bulletin 67.

AIRETOOL manufacturing company
SPRINGFIELD, OHIO
30 years' experience in pneumatic tools

BRANCH OFFICES: New York, Chicago, Tulsa, Philadelphia, Houston, Baton Rouge. **REPRESENTATIVES** in principal cities of U.S.A., Canada, Mexico, South America, England, Europe, Puerto Rico, Italy, Japan, Hawaii. **EUROPEAN PLANT:** Vlaardingen, The Netherlands. **CANADIAN PLANT:** Brantford, Ontario

CIRCLE 390 READER SERVICE CARD

CIRCLE 388 READER SERVICE CARD

SEARCHLIGHT SECTION

(Classified Advertising)

EMPLOYMENT: BUSINESS: "OPPORTUNITIES" :EQUIPMENT :USED OR RESALE

EUROPEAN COMMON MARKET

JOINT VENTURE - SELLING AGENCY

Belgian Manufacturer

of steel flanges, in a fully equipped 110,000 sq. ft. plant including presses up to 600-ton, seeks an

AMERICAN COMPANY

interested in having its own stampings to be produced and sold in Europe.

Instead of an association would also consider the sale of the existing plant.

WRITE:

Leon G. Rucquoi & Associates Inc.
30 Rockefeller Plaza, New York 20, N. Y.

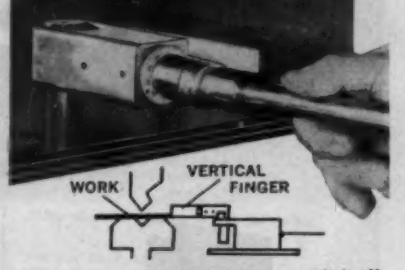
CIRCLE 500 READER SERVICE CARD

Make GAUGE CHANGES In seconds—Safely!

NEW aac

QUICKGAGE

for POWER PRESSES, PRESS BRAKES, SHEARS



To change gauge setup quickly just switch off Quickgage and re-adjust position with a Q-wrench — out in front of the die where hands are safe. Switch on and the setting is locked. Accurate to .001". Quickgage saves setup and operating time in multiple bending, step gauging or for normal gauging. Can even be used on shears. For information write Dept. A-6.

AMERICAN ACTUATOR CORP.
aac
P. O. Box 384,
Stamford, Connecticut

CIRCLE 392 READER SERVICE CARD

A Grieder Tube Cut-Off Machine will produce 4500 to 6500 cut-offs per hour

Grieder Tube Cut-Off Machines are 3 to 8 times faster than others, and speed is only one of the cost saving advantages they provide. For example:

- $ Cut tubing of any shape to any length—steel, copper, brass, aluminum and alloys. Continuous automatic operation.
- $ Lengths can be held to plus or minus .002" on light wall tubing and to .003" on heavier.
- $ Precision clamping dies prevent tube distortion and produce a quality cut. Tube does not rotate.
- $ Thousands of cuts without grinding. Blades can be sharpened on standard tool room equipment and used for as many as a million cuts.

Write for literature, stating tube sizes and production requirements.

Grieder
TUBE CUT-OFF MACHINES

GRIEDER INDUSTRIES, INC.
P. O. Box 169 • Bowling Green, Ohio

Please send bulletin describing Grieder Tube Cut-Off Machines.

NAME_____
COMPANY_____
CITY_____ ZONE____
STATE_____

CIRCLE 393 READER SERVICE CARD

HARVEY
GOLDMAN
and COMPANY

CONFIDENCE
BUILT ON 51 YEARS OF SERVICE

BROACHES

—AS LATE AS 1953—

VERTICAL SURFACE

Tons	STROKE	MAKE	MODEL	RAMS	TABLES
10	54"	Cincinnati	10-54	Dual	Swivel
10	54"	Colonial	VA2-10-54-D2	Dual	Shuttle
15	78"	LaPointe	SRV-15-78	Single	Reciprs.
15	60"	Colonial	VAI-15-60-SL	Single	
25	96"	American	SBD 96-25	Dual	Shuttle
30	72"	American	SBD 72-30	Dual	Swivel
10	84"	American	T-10-36	Single	Tri-Way
6	42"	Colonial	RD-6-42	Single	Stationary

HORIZONTAL

Tons	STROKE	MAKE	MODEL	RAMS
30	60"	LaPointe	4L	Single
6	48"	Oilgear	XL-12	Single
50	78"	LaPointe	HP-100	Single

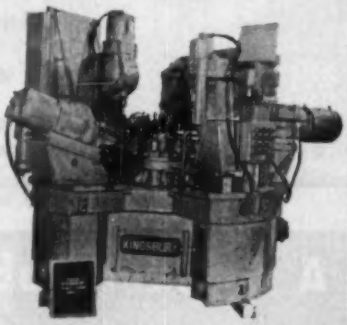
KINGSBURY
AUTOMATIC DRILLING & TAPPING MACHINES

— AS LATE AS 1955 —

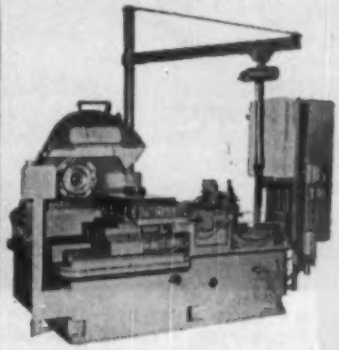
BASES: 60", 72", 80" and 84" dia.
TABLES, AUTOMATIC INDEXING 12", 14", 16", 20", 24", 30" and 42" dia.
HEADS, DRILLING & TAPPING #8, #14, #18, #22 and #30.
BRACKETS Vertical, Tunnel type & Angle.

ENGINEERING & RETOOLING SERVICE AVAILABLE

Send us a print or sample part



MODEL 330
NEW BRITAIN



BORING, TURNING & FACING MACHINE *Mfg.* 1952

- In New Condition.
- Single End, Single Spindle.
- Machine will bore, turn and face, either straight or on irregular contour.
- Two cam - actuated Tables, with opposed Air Cylinders.
- Infinite Spindle speeds with variable DC Drive.
- Coolant Tank & Pump.
- 12" Air Cylinder on Spindle.
- Jib Crane with Air Hoist, for work handling.
- Weight—18,500#.

Guaranteed Acquisition Cost in 1952— $48,000.
Price — $5,250.00

OTHER OUTSTANDING BUYS
MANY NEW SINCE 1952

14" x 18" x 60" MATTISON Hyd. Surface Grinder.

#4 KEARNEY & TRECKER Universal Mill, 1000 RPM, Dividing Head, Vertical Head.

Model EG and E1 CLEVELAND Lead-Screw Tappers, ⅝" capacity.

F1100-36 CLEARING 100 Ton Press, All-Steel, 12" stroke, 16" shut height 36" x 36" Bed, Air-Clutch.

B4B Natco Holesteel Multiple Spindle Drill, 48 Adjustable Arms and Spindles, #2 Taper.

KELLER TYPE B63 AUTOMATIC DUPLICATOR 144" Horiz., 75" Vert., Cap., 10' x 14' Bed, 92° Angle Plate, MG Set, Chip Conveyor.

FOSDICK #42 JIG BORER 22" x 42" Table, 42" Travel, 1500 RPM, Serial #15280.

#W-8 BAUSH MULTIPLE SPINDLE DRILLS Drill Area 42" x 48", 16 Spindles 2½" in Diameter 48" Index Table.

12" x 72" CINCINNATI Universal Grinder, Internal Attachment.

C4A NATCO Holesteel Multiple Spindle Drill, 64 Spindles, 48" dia. Rotary Table.

#33 SUNDSTRAND FLUID SCREW SIMPLEX MILL, 120" Table travel.

#W8 4-SPINDLE CONE 2⅝" Automatic Cut-Off Machine.

WRITE, WIRE OR PHONE
HARVEY GOLDMAN & COMPANY
3910 SCHAEFER ROAD • TELEPHONE Tiffany 6-4450
DEARBORN 2, MICHIGAN (Suburb of Detroit)

SEARCHLIGHT SECTION

ADVERTISERS' INDEX AND BUYERS' REFERENCE

Listed below are used, surplus new and rebuilt machine tools or services as advertised in this section.

The numbers after the advertiser's name, indicates the products or services offered by the advertiser.

1. Accessories
2. Automatics
3. Balancing Machines
4. Bending Machines
6. Boring Mills
7. Broaching Machines
9. Centering Machines
10. Chucking Machines
13. Cutting Off Machines
16. Drilling & Reaming Machines
17. Electric Motors
18. Engraving Machines
23. Gear Cutting Machines
24. Grinding Machines
25. Heat Treat Furnaces
26. Honing & Lapping Machines
29. Lathes
33. Milling Machines
37. Planers
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41. Presses
46. Roll Formers
48. Saws
50. Shapers
51. Shears
56. Threading & Tapping Machines
58. Welding Equipment

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SEARCHLIGHT Equipment Locating SERVICE

"No Cost or Obligation"

This service is aimed at helping you, the reader of "SEARCHLIGHT," to locate rebuilt and used machine tools and equipment, not currently advertised. (This service is for USER-BUYERS only.) No charge or obligation.

How to use: Check the dealer ads to see if what you want is not currently advertised. If not, send us the specifications of the equipment and/or components wanted on the coupon below, or on your own company letterhead to

SEARCHLIGHT EQUIPMENT LOCATING SERVICE
c/o American Machinist/Metalworking Manufacturing
Classified Advertising Division, P.O. Box 12, N. Y. 36, N. Y.

Your requirements will be brought promptly to the attention of the equipment dealers advertising in this section. You will receive replies directly from them.

Searchlight Equipment Locating Service, c/o Classified Advertising
American Machinist/Metalworking Manufacturing, P.O. Box 12, N.Y. 36, N.Y.

Please help us locate the following equipment:

.....

.....

.....

NAME .....

TITLE ..... COMPANY .....

STREET .....

CITY ..... ZONE ..... STATE .....

6/13/60

MACHINE TOOLS— FOR SALE

RBG = Rebuilt Condition Guaranteed
RCG = Reconditioned—Guaranteed
*Indicates 1940+ Model **Indicates 1950+

BORING MILLS
*24" Bullard VTL RCG
*74" Bullard "Cutmaster" VTL
*4 Sellers Horiz. Tbl Type

DRILLS, RADIAL
*3' x 11" Carleton, Tap'g Ser IA-822
*4'x11' Amer. "H. Wizard" Tbl. (1943)
*5'x11' Carleton #4 MT, Ser. IA1418

DUPLEX BROACH
**5 ton—42" Cinc. Vert. Hydro (1950) RBG

GRINDERS, MISC.
**180 Sheffield, Multiform (1957)
*#35 Excello Thread, 3 way dresser, RBG
*109 Bryant Int. New Spdl. (1947) RBG.
*30 x 48 Landis CHW (1952)
**2 Cinc. Centerless, Hydr Profile Dress

GRINDERS, SURFACE
*18A2 Blanchard 2 spdl. autom. Sz'g. (1948)
*30 x 96 x 120" Thompson Horiz. Hydr.

JIG BORER
*1830 Cleerman, 1000 RPM, R&I Ser CJB187

LATHES
**12 x 20 Rivett 1020E T.R. Model
**20 x 72 Monarch Tracer, Thrdg., etc.
*30 x 96 Niles "Timesaver" T.A. 3J, 4J RBG
*74" Star "T" Lathe, 15 HP

LATHES, TURRET
*#3 Gisholt, Barfeed, 1948, Excel.
**#5 J&L, Hard. Ways, Assess (1951)

MILLS
*9J Garton Vert. 4000 RPM RCG
**33—2448 Sundstrand Rigidmill 15 HP (1952)
*#4-48 Cinc. Hydrom., R & F Tracer, RCG
*#33—1448 Sundstrand 600 RPM (1944)
*56 x 96 Cinc. Hydrom., Simplex RCG
**#6CK K&T Horiz 18 x 168 Tbl. 25 HP (1953)

MILLS, 3 DIMENSION
5' x 5' x 14' converted planer type, Rblt. Cond.
4' x 4' x 12' converted planer type, Rblt. Cond.

PRESSES
**65 Ton Federal OBI 4" Str., Air B.
*110 Ton AS Niag. OBI, 6" Str RBG
*300 ton Verson Hydr. 44x60 bed, 28" str., 125 HP

SAWS
**18" #8 Marvel Tilting Vert. Band
*20" DoAll Vert. Bandsaw W/Welder
**36" DoAll H.S. Vert. Bandsaw, Hydr. Tbl (1953)

"MIDWESTERN" Machinery Company
2900 Pleasant Ave. So., Minn. 8
TAylor 5-4461

CIRCLE 503 READER SERVICE CARD

Late Models at Low Prices

BROWN & SHARPE #13 Universal & Tool Grinder, Load of tooling, 1953, $5800.00.

CONE Vert. 4 Spindle Cut-Off & Forming Automatic, 1947, 1" cap., $5500.00.

GISHOLT 4L—1944. Hard Ways, 31⅝" swing, $8500.00.

NEW BRITAIN 656 Chucker, 1942, with Collet Noses, 2" cap., like new, $2700.00.

ACME #2 Saddle type, 3⅜" bar machine, Timken, & Chucker, Hard Ways, Tooling, Bargain, $1900.00.

Grinder Cylindrical 16"x36" NORTON, live spindle, 1943, Like New, $3000.00.

GENERAL MACHINERY & EQUIPMENT CO.
140-44 S. 17th St., Harrisburg, Pa.

CIRCLE 504 READER SERVICE CARD

BRAKES PRESSES SHEARS

Will Lease or Furnish Long Terms

JOSEPH HYMAN & SONS
2600 E. Tioga St., Philadelphia 34, Pa.

CIRCLE 505 READER SERVICE CARD

35% OFF REGULAR PRICES

For: Warner & Swasey • Gisholt • Foster • Acme • Bardons & Oliver • Jones & Lamson • Midland • Libby • Fastermatic • Potter & Johnston

Tooling is New Government Surplus • Reconditioned

TURRET LATHE TOOLING

Everything in machine shop supplies from one dependable service . . .

Edward Andrews Tools & Machinery Company

Send for catalog No. 1-50 for Complete listing of Turret Lathe Tooling

Telephone: Lincoln 5-4900 Jordan 4-5527 (Detroit Office)

400-80 West Nine Mile Rd., Hazel Park, Mich.

CIRCLE 506 READER SERVICE CARD

PRACTICALLY NEW PRESSES

825 tons, Bliss #90½-90 Bed 90"x84", Str. 8"
100 tons, Bliss #0½-60, Bed 60"x30", Str. 6"
125 tons, Bliss #2½-48W, Bed 48"x30", Str. 6"
Waree—600 Tons Double Crank Bed 180"x84" Double Roll Feed, Uncoiler, Straightener
135 tons, Bliss #6-48, Bed 48"x30"
100 tons, Bliss #5-36, Bed 36"x28"
Verson—#82-200, Bed 96"x44", Str. 18"
Bliss #6180 High Speed Double Roll Feeds
Bliss #8458, Bed 48"x18", Str. 4"
Lolland Engine Lathe, Type N.K. 30" swing x 27' centers, 2 carriages

"If it's machinery; We have it."

NATIONAL MACHINERY EXCHANGE
138 Mott St., N. Y. CAnal 6-2470

CIRCLE 507 READER SERVICE CARD

CHOICE MODERN MACHINE TOOLS AVAILABLE

3—#36 & #52 Index single spindle automatic screw machines, New 1951 and 1952
1—1" National Acme 4 spindle automatic screw machine, Serial No. 26250
1—⅝" Gridley 6 spindle automatic screw machine, Serial No. A-560
3—6" B.S.A. single spindle automatic chucking machines, New 1952 and 1953
1—5 DE Potter & Johnston automatic chucking machine, New 1953
1—18" x 30" Monarch Model 20 Mono-Matic automatic tracing lathe, New 1953

Miscellaneous other machine tools

Write or call for photographs and additional information or machines can be seen at:

WEST ENGINEERING COMPANY, INC.
Vawter Avenue, Richmond, Virginia
Telephone Milton 4-3001

CIRCLE 508 READER SERVICE CARD

7' 12" American Radial, Late
#2 and 4½ Kling Friction Saws
12" ¼" Cincinnati Shear, 1951
10' ¼" Webb Roll, 1940
#5H K & T Plain Mill, Late
30" x 84" c American Lathe, Late
⅛" Kane & Roach Shape Straightener
27" x 22' c Niles Lathe, Late

Send for our complete listings.

COOK COUNTY MACHINERY COMPANY
1036 W. Lake Street, Chicago 7, Illinois

CIRCLE 509 READER SERVICE CARD

MOTORS • GENERATORS
TRANSFORMERS
NEW • REBUILT

ELECTRIC EQUIPMENT CO.

WORLD'S LARGEST INVENTORY
CALL COLLECT GL 3-6783
P. O. BOX 51 • ROCHESTER 1, N. Y.

CIRCLE 510 READER SERVICE CARD

UNIVERSAL GRINDER

1—Cincinnati 12" x 72", complete with Internal Grinding Attachment and all regular equipment. Serial Number 2U33F5B-1, purchased new in 1954, all Electrical Equipment AC 220-440 3 Phase 60 Cycle. This Grinder has seen less than three (3) years service with care.

STANDARD MACHINERY & SUPPLY CO., INC.
183 Oliver Street, Boston 10, Massachusetts

CIRCLE 514 READER SERVICE CARD

FOR SALE

64" Giddings & Lewis Hypro Vertical Boring Mill, 1952
12"x12"x60" Thompson Type B Hydraulic Surface Grinder, 1942
#TG636 J & L Auto. Thread Grinder, 1940, univ. truing
48" x 33' cc Niles Heavy Duty Geared Head Lathe, two carriages, 1940
#3-36 Cincinnati Duplex Hydromatic Miller, 1951
#4A Warner & Swasey Saddle Type Turret Lathe, 1944, 12½" hole

J. L. LUCAS & SON, INC.
Bridgeport 5A, Connecticut

CIRCLE 513 READER SERVICE CARD

16' 1" Cap. Wickes Pyramid Type Bending Roll, Motor Drive 21" Top Roll.

No. 5 Jones & Lamson Univ. Turret Lathe Bar Feed, Chuck, Collets & Tooling — 1942

Send For Our Complete Listings

SEGAL MACHINERY CO.
117½ S. Clinton St. Chicago 6, Illinois

CIRCLE 515 READER SERVICE CARD

— NEW 4th Printing —

MACHINE TOOL RECONDITIONING & the Art of Hand Scraping

Write for folder describing illustrated book

MACHINE TOOL PUBLICATIONS
215 Commerce Bldg., Fourth & Wabash Sts.
St. Paul 1, Minn.

CIRCLE 516 READER SERVICE CARD

WANT MORE INFORMATION on SEARCHLIGHT ADVERTISEMENTS?

- Take advantage of a new service available on Classified advertisements to secure more information. Use the handy, prepaid reader service cards (at the end of the magazine) to bring you more data. The Reader Service number appearing under each advertisement need only be circled on the card.
- Use this time-saving service to keep abreast of the latest in used, rebuilt, surplus new equipment, employment or business opportunities.

RE-BUILDING *at its Best*

Shown is a Miles mechanic preparing the surface of a new aluminum bronze wearing plate for proper lubrication. This is typical of all Miles re-building . . . rebuilding at its very best.

Drill, No. 15½ Fast Gurte hyd. vert. driver for multi head
Drill, Multiple, 12 spindle Davis & Thompson Rotomatic, vert. 20 HP, new 46
Engraver or Duplicator, Model BL2416 3 spindle Pratt-Whitney Keller, late, (2)
Gear Shaper, No. 7A Mod. 7128A Fellows H.S. Univ.
Gear Tester, No. 13 Gleason universal for straight and spirals
Gear Hobber, Type A Barber Colman, new 44
Gear Shaver, Model GCC 9" Red Ring
Grinder, Cylindrical, Universal 12" x 48" Cincinnati Filmatic brg., late
Grinder, Cyl. Plain, 22" x 72" Landis type C, 42
Grinder, Internal, No. 271 Heald plain, swivel work head, new 51
Grinder, Internal, No. 24-36 Bryant hole grinder, MD. late (3)
Grinder, Tool, Cincinnati Monoset, MD. new 45
Grinder, Thread, Model 33 Ex-Cell-O automatic precision, rebuilt in 58, good
Hone, Model 224 Barnes vertical internal hyd, late
Lapper, No. 821-2 Micromatic, new 53
Lathe, Automatic, Model 10 x 34" Sundstrand, two front, two rear slides, new 46
Lathe, Automatic, 28" x 37" Fay 3 front and 1 rear slide, 15 HP MD
Lathes, Engine, 25" x 72" cc Axelson Model E hy. dy. geared head, late
Lathe, Production, 12" x 18" Lipe Carbo semi-automatic, Timken brg.
Lathe, Turret, No. 2 W & S. new electric bar feed, hi-low head, MTR in base
Lathe, Turret, No. 4 J & L, ram type univ.
Lathe, Turret, No. 5 Gisholt ram type univ.
Lathe, Turret, No. 2L Gisholt univ. saddle type
Lathe, Model 10 x 72" Sundstrand center drive automatic, new 47
Mill, No. 5-48 Cincinnati hydromatic bed type horizontal duplex
Mill, Boring, Horiz. 4" bar Universal Tri-Way, late (2)
Mill, Plain No. 2 Cincinnati high speed, dial type, MD. 1941
Slotter, 36" Rockford vertical hydraulic, new 43-43 (2)

OVER 1,000 NEW AND USED MACHINE TOOLS IN STOCK
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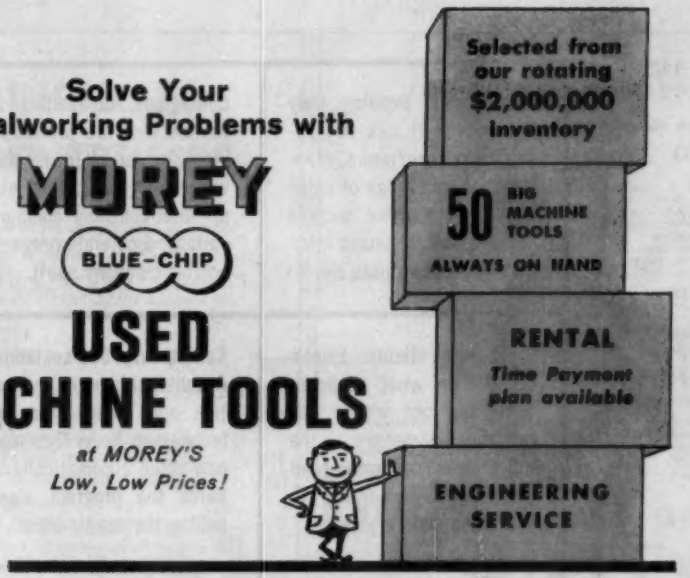
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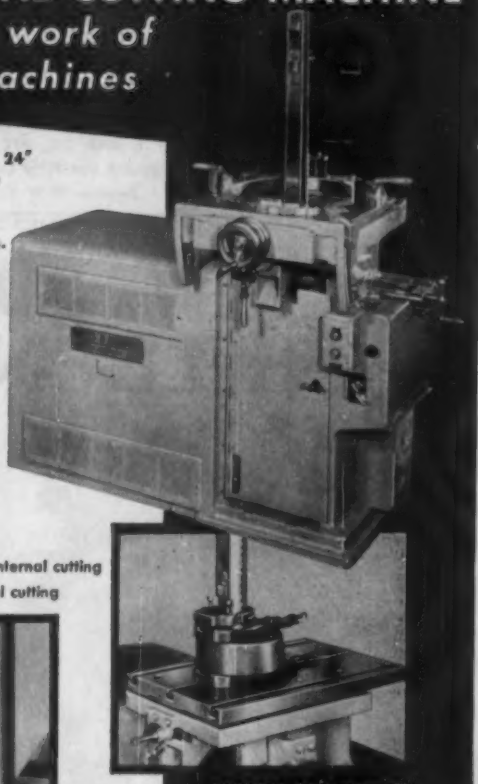
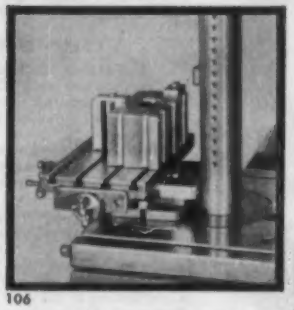


Right: Set-up for internal cutting

Below: Set-up for external cutting



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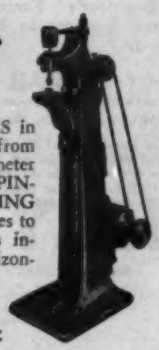

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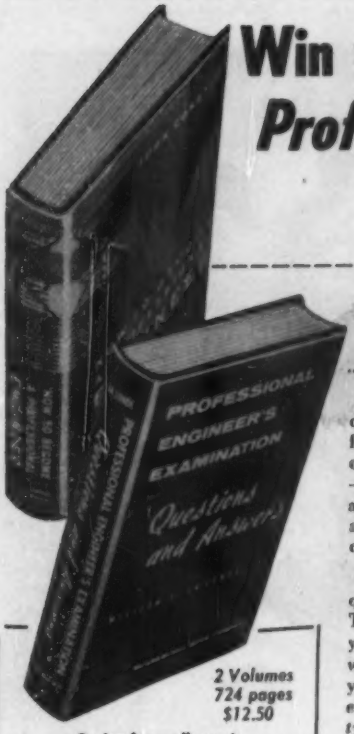

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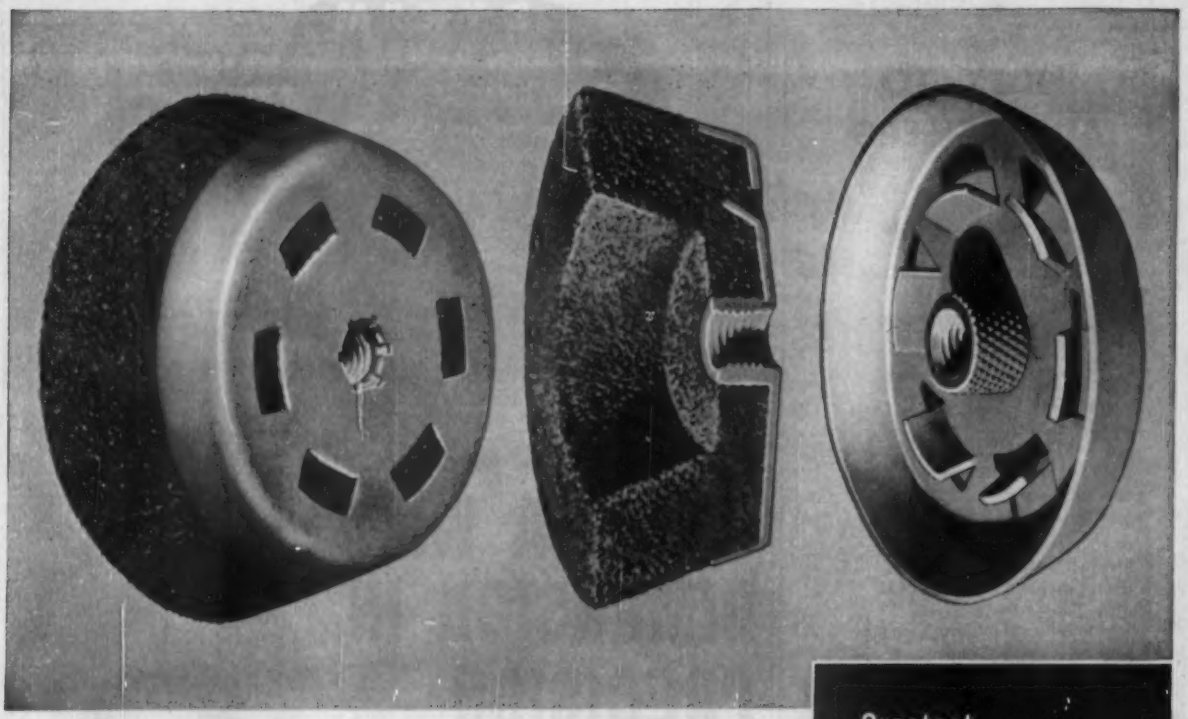

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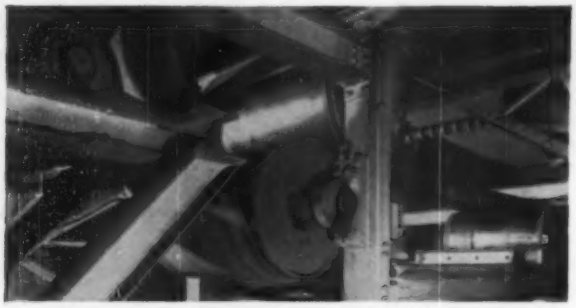

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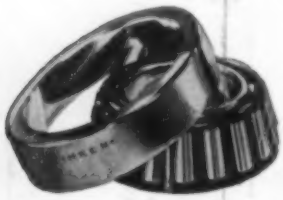

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